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The Metallurgical Examination and Inspection of Apache Tail Rotor Strap Pack Laminates and Assemblies

by Scott M. Grendahl

ARL-TR-2018 July 1999

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Abstract

The U.S. Army Research Laboratory-Weapons and Materials Research Directorate (ARL-WMRD) performed a dimensional inspection and metallurgical investigation of AH-64 Apache tail rotor strap pack assemblies and individual laminate sets. All of the dimensional critical characteristics were examined in an attempt to determine the cause of a buckling phenomenon within the strap pack assemblies. Conformance to the manufacturer's governing specifications with respect to the material, heat treatment, and marking requirements was also investigated. The cause of the buckling was attributed to a combination of factors. Dimensional nonconformances were identified. Most of the hole diameters were found to be well below the specified range, causing the assemblies to be forced together. Transposition of the laminates during manufacture was also highly likely to have occurred, adding to the misalignment of the assembly. All other characteristics of the laminates and assemblies were found to conform to the governing part drawings and specifications.

Acknowledgments

The author would like to thank Mr. Victor K. Champagne and Mr. Marc S. Pepi of the U.S. Army Research Laboratory (ARL), Weapons and Materials Research Directorate (WMRD), Aberdeen Proving Ground (APG), MD, for fruitful discussions concerning this endeavor. Additionally, the author would like to acknowledge Mr. James Catalano, ARL, APG, MD, and Mr. Andrew Beaupre of the Worcester Polytechnic Institute, Worcester, MA, for their data contributions to this work.

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1. Introduction

The U.S. Army Aviation and Missile Command (AMCOM) requested an investigation consisting of metallurgical examination and dimensional inspection of Apache tail rotor strap pack assemblies and individual laminate sets. The laminate material is very thin (approximately 0.014 in) sheet AM-355, a semiaustenetic stainless steel. The U.S. Army Research Laboratory, Weapons and Materials Research Directorate (ARL-WMRD), received two Quality Deficiency Report (QDR) exhibits, which were to be used as the assemblies for inspection. Additionally, nine individual laminate sets were sent to ARL-WMRD for inspection (serial numbers [SN] 003343-1167, -1168, -1169, -1172, -1173, -1174, -1175, -1176, and -1177). ARL-WMRD was requested to perform a dimensional inspection of the two QDR assemblies per the governing specifications and also verify that they were properly assembled. Additionally, ARL-WMRD was requested to inspect three laminates (selected at random) from each separate laminate set received for conformance to the governing documents. Later, this was altered to include a complete dimensional inspection of one laminate set selected at random. Verification of surface finish, edge finish, and hole finish and all other critical characteristics was to be determined as prescribed by the governing documents. ARL-WMRD was also requested to perform a full metallurgical investigation of one laminate from both QDR assemblies received to verify material and heat treatment. Finally, it was requested of ARL-WMRD to substantiate that all components were marked and designated in accordance with the appropriate specifications.

2. Objectives

The purpose of this work was to determine the cause of the buckling phenomenon on the two QDR tail rotor assembly exhibits. Additionally, all components involved were evaluated for conformance to the governing manufacturing, process, and identification specifications of the assembly.

3. Experimental Procedure

3.1 Visual Inspection and Light Optical Microscopy. Both QDR exhibits (designated W81CL8940027 for SN 003343-0899 and W81CL8940085 for SN 003343-1548) received by ARL-WMRD were visually inspected [1, 2]. It was noted that both exhibits experienced extensive buckling between the individual laminates that make up the assemblies. The assembly is governed by the McDonnell Douglas drawing package BP-7-211421035 [3]. Figures 1 and 2 depict QDR exhibit 003343-1548 (1548) as received by ARL-WMRD.

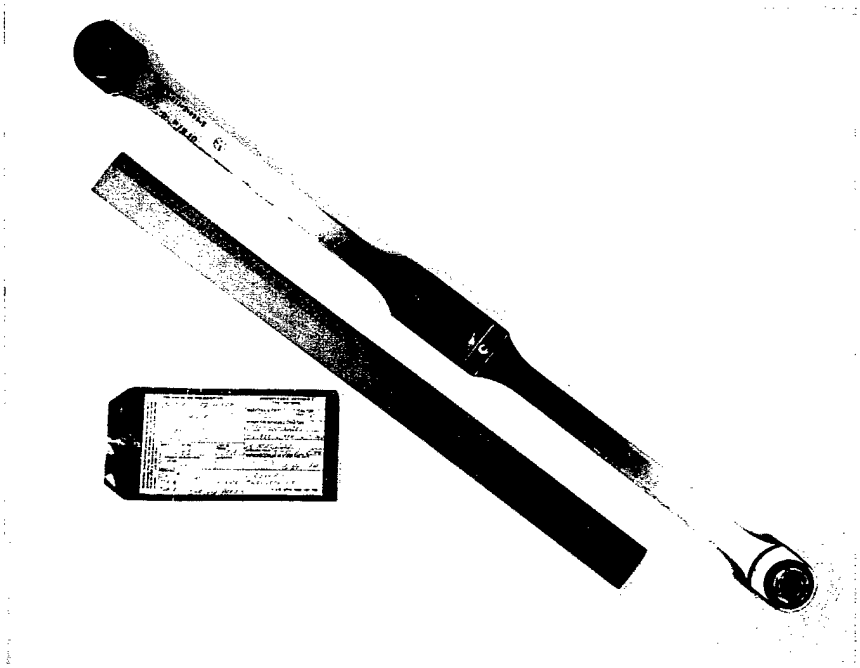

Figure 1. Macrograph of the As-Received Strap Pack 1548 (Top View). (Scale in Inches.)

Figures 3 and 4 show QDR exhibit 003343-0899 (0899) as received by ARL-WMRD. The individual quality deficiency reports designate buckling and/or displacement of the first laminate for exhibit 1548 and the third and eleventh laminate for exhibit 0899. These findings were verified by ARL-WMRD via optical microscopy. The first laminate was visibly buckled on exhibit 1548, as depicted in Figure 5. Closer examination of the white outlined box in Figure 4 reveals the buckling of the third and eleventh laminates on exhibit 0899. The additional nine

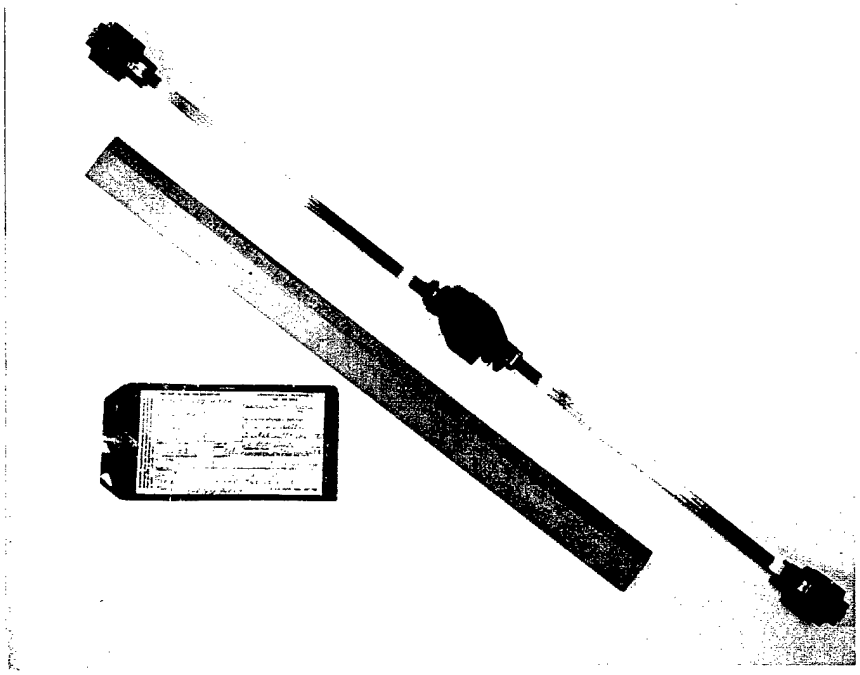

Figure 2. Macrograph of the As-Received Strap Pack 1548 (Side View). (Scale in Inches.)

laminate sets received by ARL-WMRD were also inspected for surface finish and marking requirements per EPB-4-321, Rev. E [4]. All components had surface finishes well within specification. The individual laminates had surface finishes ranging from 2–4 Ra (μm), well within the specified value of 8 Ra (μm). The laminates are governed by the McDonnell Douglas laminate drawing package, BP-7-211421023 and the AM-355 material specification, HMS-6-1073, Rev. E [5, 6]. All tail rotor laminates were blanked within 15° of the longitudinal grain direction of the components in agreement with EPB-4-321, Rev. E [4]. The components were also correctly marked and/or stamped according to the governing identification and serialization specifications, HP 8-5 and HP 8-8 [7, 8].

Figure 3. Macrograph of the As-Received Strap Pack 0899 (Top View). (Scale in Inches.)

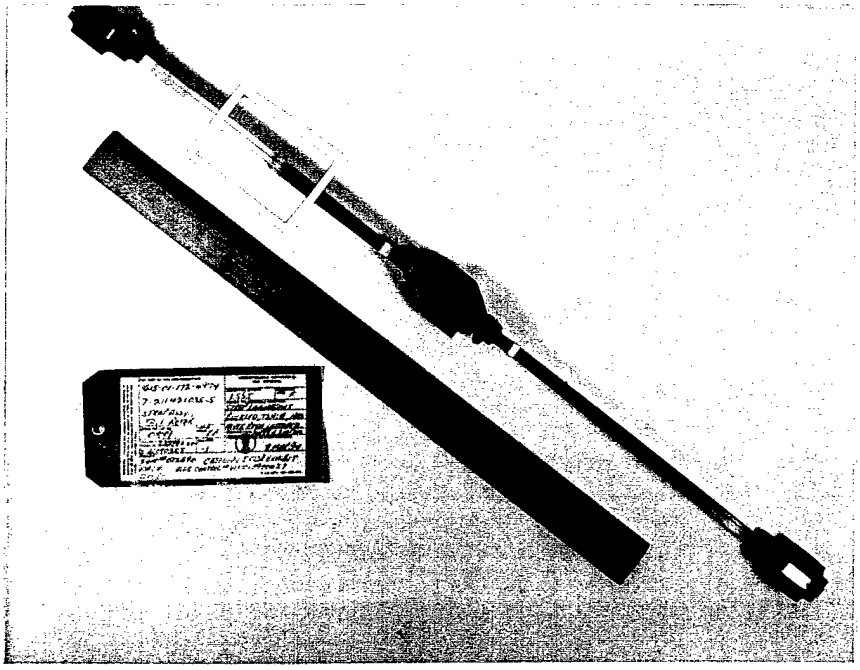

Figure 4. Macrograph of the As-Received Strap Pack 0899 (Side View). (Scale in Inches.)

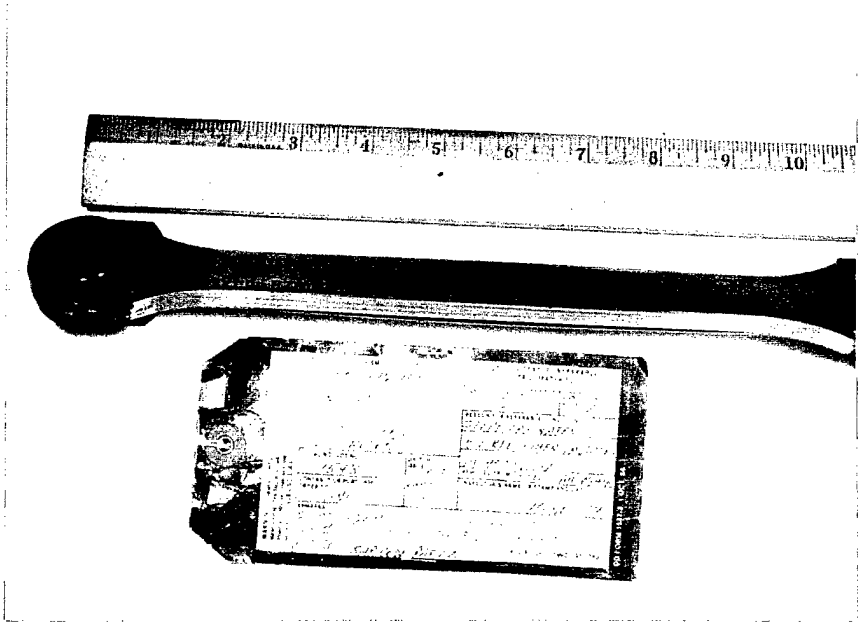

Figure 5. Macrograph of the Buckling on Strap Pack 1548. (Scale in Inches.)

3.2 Dimensional Inspection. A three-axis coordinate measuring machine (CMM) was used to check the dimensional conformity of the strap pack laminates. It must be understood in an analysis of the data that the laminates were edge-finished prior to dimensional inspection. This is significant, since the CMM employs a spherical ruby stylus when acquiring measurement data. If the edges of the laminates are also rounded, slight inaccuracies may exist in the measurements obtained due to the extreme thinness of the laminates (approximately 0.014 in). Figure 6 illustrates this phenomenon. However, it is important to note that this small source of error would not account for hole dimensions with measured value smaller than that specified, as the drawing illustrates. If the spherical stylus caused error to be introduced, the dimensions of the holes would be artificially inflated rather than reduced. Therefore, the slight inaccuracy might only explain dimensions that are out of tolerance by being larger than specified. Dimensions found to be smaller than specified cannot be explained away under this argument and are of significant concern. This inaccuracy in measurement due to the edge finishing and spherical stylus is very small, approximately 0.0005 in maximum, and is exaggerated in Figure 6.

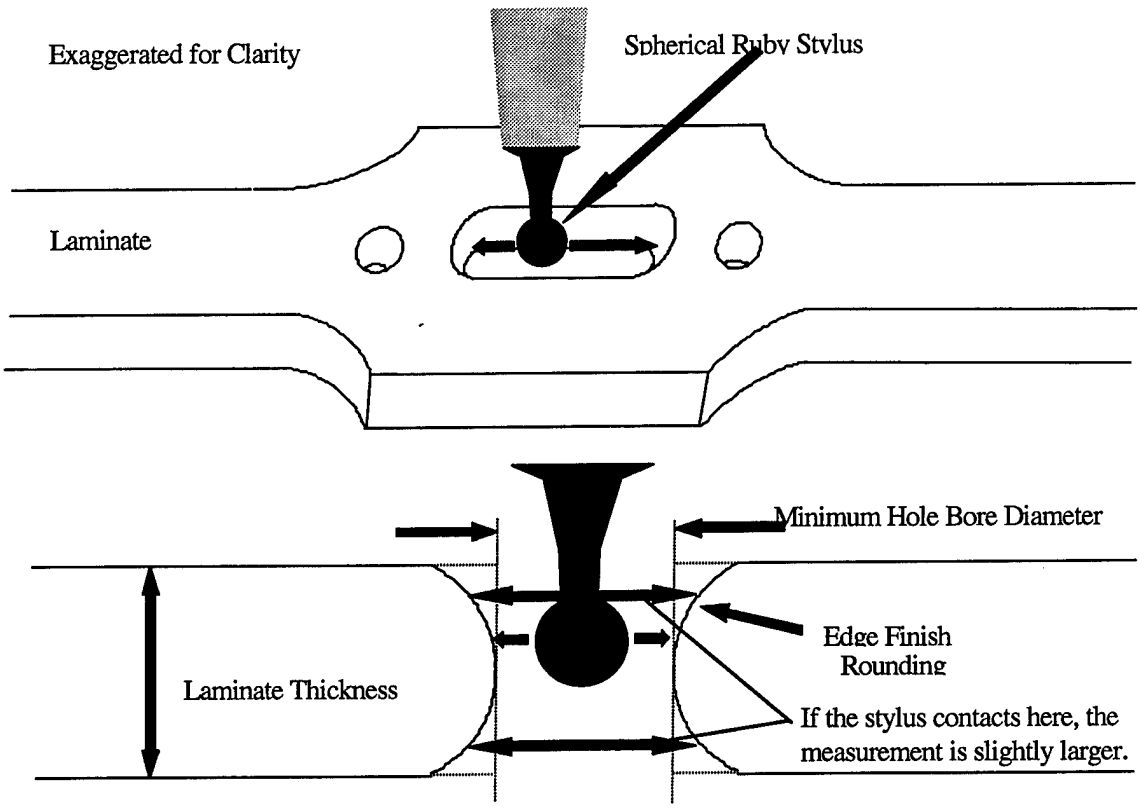

Figure 6. Illustration of the Measurement Inaccuracy Due to Edge Finishing.

Table 1 is a listing of the measurements taken by the CCM during the inspection of the QDR exhibit tail rotor strap pack assemblies, 1548 and 0899. Refer to the laminate illustration, Figure 7, for the individual measurement locations.

4. Discussion

The boxed data in Table 1 indicate the most likely source of the buckling. It can be seen from the data for dimensions E and F that the average value of DIM. E is larger by 0.006 in (average value DIM. E = 1.1294 in and average value DIM. F = 1.1233 in, neglecting the boxed data). The transposition occurs when a laminate is rotated 180° and inserted back into the stack. Therefore, DIM. E becomes DIM. F for the transposed laminate. It can be seen in the data that the transposed laminate's DIM. E values closely resemble the other laminate's DIM. F values.

Table 1. Dimensional Data for QDR Exhibits 1548 and 0899

Laminate	DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	DIM. F	HOLE 1	HOLE 2	HOLE 3	HOLE 4
Specification	23.200	11.600	11.600	2.250	1.125	1.125	0.6883	0.6883	0.1955	0.1955
Tolerance	± 0.010	± 0.010	± 0.010	± 0.010	± 0.010	± 0.010	+ 0.0002 - 0.0003	+ 0.0002 - 0.0003	± 0.0005	± 0.0005
#1548 - 1	23.20456	11.60183	11.60272	2.25099	1.12874	1.12225	0.68314	0.68443	0.19135	0.19213
#1548 - 2	23.20537	11.60260	11.60276	2.25192	1.12187	1.13005	0.68486	0.68523	0.19210	0.19622
#1548 - 3	23.20522	11.60138	11.60384	2.25078	1.11997	1.13080	0.68531	0.68611	0.19266	0.19195
#1548 - 4	23.20614	11.60289	11.60325	2.25194	1.12089	1.13105	0.68582	0.68586	0.19331	0.19233
#1548 - 5	23.20673	11.60381	11.60292	2.25018	1.12116	1.12901	0.68625	0.68350	0.19139	0.19238
#1548 - 6	23.20611	11.60287	11.60324	2.25046	1.11985	1.13062	0.68531	0.68760	0.19168	0.19322
#1548 - 7	23.20587	11.60316	11.60271	2.25145	1.12176	1.12969	0.68687	0.68330	0.19110	0.19196
#1548 - 8	23.20560	11.60240	11.60320	2.25260	1.12170	1.13090	0.68520	0.68500	0.19290	0.19220
#1548 - 9	23.20480	11.60250	11.60230	2.25030	1.12100	1.12930	0.68590	0.68520	0.19470	0.19380
#1548 - 10	23.20700	11.60290	11.60420	2.24930	1.11930	1.12990	0.68630	0.68580	0.19340	0.19300
#1548 - 11	23.20600	11.60310	11.60290	2.25090	1.12210	1.12980	0.68580	0.68600	0.19400	0.19290
#1548 - 12	23.20550	11.60280	11.60260	2.25230	1.12240	1.12990	0.68530	0.68570	0.19290	0.19140
#1548 - 13	23.20590	11.60310	11.60280	2.25130	1.12170	1.12950	0.68710	0.68640	0.19390	0.19390
#1548 - 14	23.20570	11.60310	11.60260	2.25150	1.12120	1.13030	0.68590	0.68570	0.19360	0.19290
#1548 - 15	23.20680	11.60330	11.60350	2.25160	1.12150	1.13010	0.68680	0.68720	0.19480	0.19370
#1548 - 16	23.20570	11.60290	11.60280	2.25070	1.12120	1.12940	0.68570	0.68600	0.19320	0.19320
#1548 - 17	23.20610	11.60290	11.60320	2.25180	1.12190	1.12990	0.68780	0.68800	0.19490	0.19430
#1548 - 18	23.20600	11.60290	11.60320	2.25060	1.12140	1.12990	0.68740	0.68730	0.19440	0.19370
#1548 - 19	23.20620	11.60290	11.60330	2.25180	1.12240	1.12920	0.68740	0.68630	0.19440	0.19340
#1548 - 20	23.20530	11.60250	11.60280	2.25200	1.12150	1.13050	0.68680	0.68570	0.19400	0.19420
#1548 - 21	23.20620	11.60290	11.60330	2.25050	1.12120	1.12930	0.68600	0.68690	0.19310	0.19250
#1548 - 22	23.20570	11.60290	11.60280	2.25120	1.12180	1.12930	0.68540	0.68680	0.19270	0.19210
#0899 -1	23.20560	11.60270	11.60290	2.25170	1.12840	1.12320	0.68770	0.68740	0.19500	0.19470
#0899 - 2	23.20600	11.60290	11.60320	2.25250	1.12940	1.12300	0.68780	0.68760	0.19480	0.19470
#0899 - 3	23.20540	11.60270	11.60260	2.25220	1.12280	1.12940	0.68710	0.68750	0.19630	0.19580
#0899 - 4	23.20560	11.60270	11.60290	2.25190	1.1289	1.12300	0.68710	0.68680	0.19530	0.19500
#0899 - 5	23.20460	11.60210	11.60250	2.25220	1.12860	1.12350	0.68730	0.68730	0.19480	0.19400
#0899 - 6	23.20560	11.60240	11.60320	2.25220	1.12860	1.12360	0.68700	0.68700	0.19540	0.19500
#0899 -7	23.20530	11.60240	11.60290	2.25220	1.12880	1.12350	0.68740	0.68740	0.19530	0.19570
#0899 - 8	23.20550	11.60290	11.60290	2.25280	1.12940	1.12340	0.68710	0.68670	0.19410	0.19460
#0899 - 9	23.20540	11.60260	11.60270	2.25230	1.12920	1.12310	0.68720	0.68760	0.19530	0.19570
#0899 -10	23.20520	11.60250	11.60280	2.25150	1.12880	1.12270	0.68730	0.68730	0.19490	0.19410
#0899 -11	23.20560	11.60280	11.60280	2.25360	1.12300	1.13060	0.68840	0.68840	0.19430	0.19470
#0899 -12	23.20570	11.60290	11.60280	2.25270	1.12950	1.12320	0.68660	0.68660	0.19490	0.19440
#0899 -13	23.20550	11.60250	11.60300	2.25300	1.12960	1.12340	0.68730	0.68720	0.19530	0.19450
#0899 -14	23.20500	11.60250	11.60250	2.25310	1.12940	1.12360	0.68670	0.68660	0.19440	0.19440
#0899 -15	23.20520	11.60260	11.60260	2.25310	1.12950	1.12350	0.68730	0.68630	0.19470	0.19420
#0899 -16	23.20500	11.60250	11.60250	2.25280	1.12960	1.12330	0.68790	0.68740	0.19500	0.19540
#0899 -17	23.20560	11.60270	11.60290	2.25340	1.12990	1.12350	0.68720	0.68730	0.19470	0.19520
#0899 -18	23.20590	11.60310	11.60280	2.25340	1.12970	1.12370	0.68660	0.68710	0.19470	0.19440
#0899 -19	23.20550	11.60270	11.60280	2.25350	1.12980	1.12380	0.68680	0.68690	0.19390	0.19420
#0899 - 20	23.20510	11.60240	11.60270	2.25370	1.13000	1.12380	0.68660	0.68660	0.19400	0.19400
#0899 - 21	23.20550	11.60280	11.60270	2.25350	1.13120	1.12230	0.68680	0.68660	0.19400	0.19470
#0899 - 22	23.20520	11.60250	11.60260	2.25320	1.12970	1.12340	0.68690	0.68710	0.19430	0.19450

Note: Boxed data indicate a transposition of the laminate about the y-axis.
Shaded data indicate values out of specification.

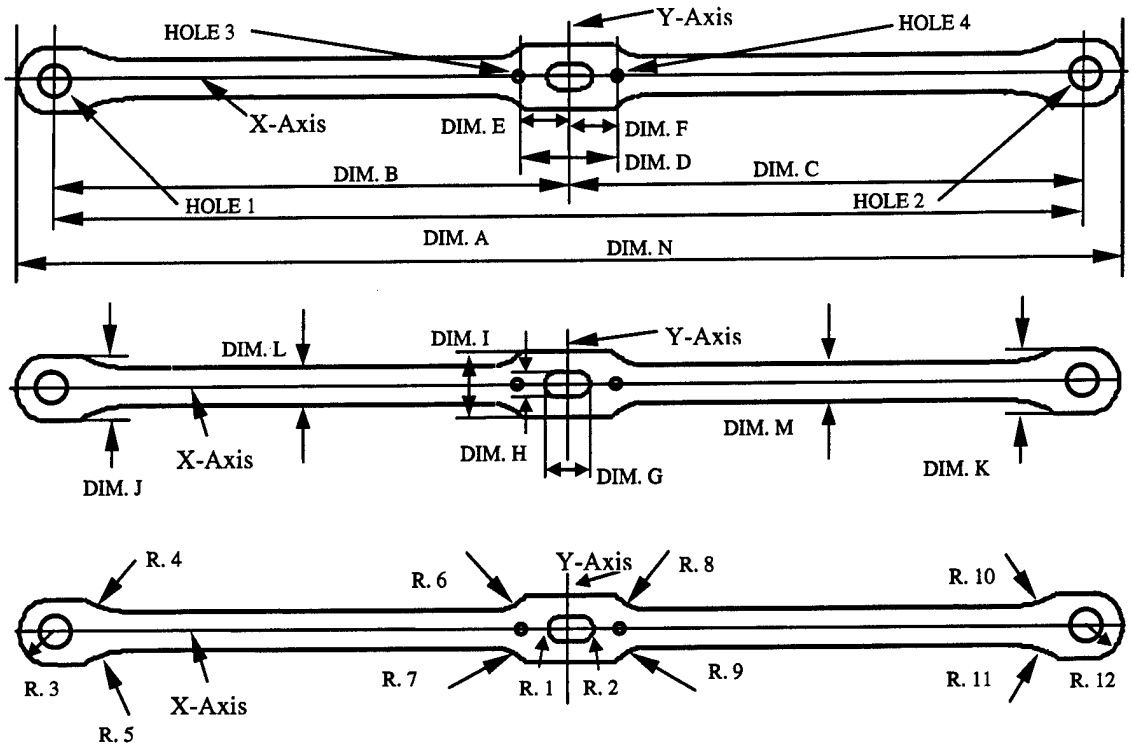

Figure 7. Illustration of the Defined Laminate Dimensions for Tables 1, 2, 3, and 4.

The converse also holds true. Once a 180° transposition about the Y-axis of a laminate has occurred, forcing a rivet through these centrally located rivet holes will cause an offset of the entire laminate. Therefore, the assembly is forced to buckle when the bushings are placed through the ends of the laminate stack. Figure 8 visually depicts the transposition and buckling scenario.

Further evidence of this scenario is suggested by the displacement/buckling location within the laminate stack as reported previously. The displacement and buckling location matches precisely with the boxed data laminate numbers in Table 1. In strap pack 1548, the first laminate is visibly displaced (refer to Figure 5), and for strap pack 0899, the third and eleventh laminates are displaced (refer to Figure 4).

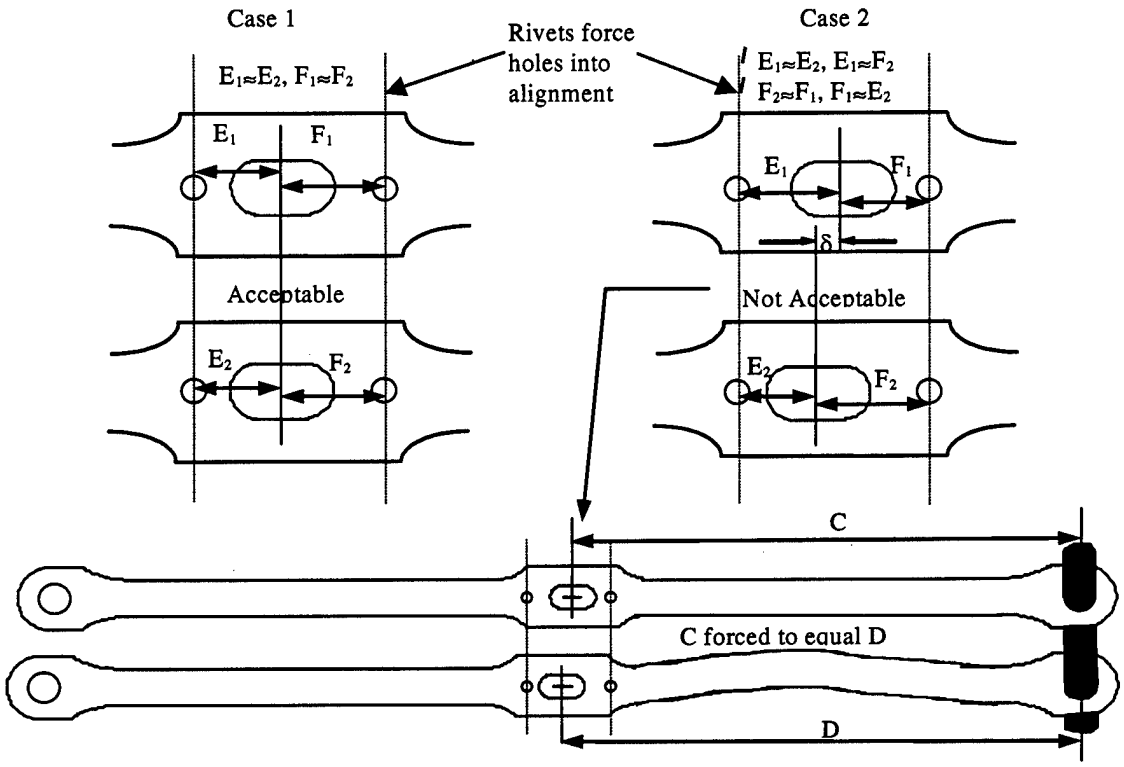

Figure 8. Illustration of the Transposition About the Y-Axis and Buckling Scenario.

Based upon these initial findings of the QDR exhibits, ARL-WMRD was asked to perform a full dimensional analysis of three randomly selected laminates from each of the nine individual laminate sets received, in addition to two single separate laminates. Tables 2–4 list the data acquired using the CMM.

The only significant finding in the data in Table 2 was that the first extra laminate inspected was considerably out of tolerance with respect to its width dimensions. The transposition event is not discernable within this data due to the absence of the data from the complete sets. Three laminates are not enough to establish a pattern in the measurement data.

Based upon the findings in Table 3, it was obvious that a complete laminate set must be dimensionally checked for the transposition about the Y-axis to be seen within a laminate set.

Table 2. Dimensional Data for Randomly Selected Individual Laminate Sets and Odd Laminates

Laminate	DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	DIM. F	DIM. G	DIM. H	DIM. I	DIM. J	DIM. K	DIM. L	DIM. M	DIM. N
Specification Tolerance	23.200 ± 0.010	11.600 ± 0.010	11.600 ± 0.010	2.250 ± 0.010	1.125 ± 0.010	1.125 ± 0.010	1.100 ± 0.010	0.660 ± 0.010	1.550 ± 0.010	1.550 ± 0.010	1.550 ± 0.010	0.790 ± 0.010	0.790 ± 0.010	24.840 REF.
1172 - 7	23.2009	11.6004	11.6004	2.2527	1.1261	1.1266	1.1042	0.6635	1.5568	1.5572	1.5569	0.7922	0.7924	24.8555
1172 - 16	23.2007	11.6003	11.6003	2.2522	1.1263	1.1259	1.1029	0.6622	1.5567	1.5579	1.5582	0.7932	0.7922	24.8534
1172 - 21	23.2005	11.6002	11.6002	2.2523	1.1262	1.1260	1.1031	0.6637	1.5570	1.5570	1.5571	0.7922	0.7922	24.8491
1173 - 2	23.2005	11.6002	11.6002	2.2526	1.1259	1.1267	1.1033	0.6641	1.5539	1.5549	1.5550	0.7906	0.7906	24.8482
1173 - 9	23.1982	11.5991	11.5991	2.2533	1.1282	1.1251	1.1028	0.6649	1.5533	1.5561	1.5562	0.7921	0.7921	24.8497
1173 - 19	23.2007	11.6003	11.6003	2.2534	1.1267	1.1267	1.1028	0.6635	1.5535	1.5573	1.5572	0.7927	0.7927	24.8541
1167 - 1	23.2007	11.6003	11.6003	2.2511	1.1259	1.1252	1.1026	0.6640	1.5539	1.5556	1.5545	0.7927	0.7910	24.8569
1167 - 8	23.2004	11.6002	11.6002	2.2511	1.1261	1.1250	1.1037	0.6634	1.5541	1.5566	1.5555	0.7910	0.7914	24.8521
1167 - 20	23.2002	11.6001	11.6001	2.2510	1.1265	1.1246	1.1030	0.6637	1.5545	1.5570	1.5572	0.7914	0.7925	24.8546
1169 - 2	23.2008	11.6004	11.6004	2.2519	1.1266	1.1253	1.1040	0.6636	1.5537	1.5555	1.5555	0.7921	0.7921	24.8569
1169 - 13	23.2006	11.6003	11.6003	2.2523	1.1269	1.1254	1.1020	0.6650	1.5556	1.5566	1.5578	0.7939	0.7939	24.8505
1169 - 22	23.2007	11.6003	11.6003	2.2518	1.1275	1.1243	1.1021	0.6644	1.5552	1.5576	1.5581	0.7947	0.7947	24.8549
1168 - 2	23.2009	11.6004	11.6004	2.2515	1.1261	1.1266	1.1036	0.6656	1.5512	1.5567	1.5561	0.7915	0.7915	24.8536
1168 - 12	23.2009	11.6004	11.6004	2.2514	1.1264	1.1250	1.1038	0.6645	1.5533	1.5566	1.5569	0.7921	0.7921	24.8569
1168 - 20	23.2004	11.6002	11.6002	2.2520	1.1265	1.1255	1.1029	0.6642	1.5541	1.5571	1.5577	0.7922	0.7922	24.8582
1174 - 4	23.2015	11.6007	11.6007	2.2515	1.1250	1.1266	1.1034	0.6651	1.5548	1.5565	1.5566	0.7933	0.7933	24.8586
1174 - 11	23.2011	11.6005	11.6005	2.2502	1.1246	1.1256	1.1057	0.6657	1.5553	1.5561	1.5571	0.7929	0.7929	24.8510
1174 - 20	23.2017	11.6008	11.6008	2.2507	1.1248	1.1260	1.1052	0.6644	1.5560	1.5571	1.5569	0.7928	0.7928	24.8547
1175 - 1	23.2009	11.6004	11.6004	2.2508	1.1248	1.1260	1.1050	0.6644	1.5546	1.5559	1.5554	0.7919	0.7919	24.8505
1175 - 12	23.2021	11.6010	11.6010	2.2512	1.1247	1.1266	1.1047	0.6653	1.5546	1.5575	1.5569	0.7930	0.7930	24.8525
1175 - 19	23.2018	11.6009	11.6009	2.2503	1.1241	1.1263	1.1040	0.6644	1.5548	1.5568	1.5576	0.7923	0.7923	24.8563
1176 - 3	23.2009	11.6004	11.6004	2.2519	1.1273	1.1246	1.1041	0.6640	1.5568	1.5570	1.5572	0.7934	0.7934	24.8569
1176 - 10	23.2004	11.6002	11.6002	2.2520	1.1269	1.1251	1.1037	0.6630	1.5570	1.5570	1.5567	0.7934	0.7934	24.8545
1176 - 21	23.2005	11.6002	11.6002	2.2515	1.1270	1.1245	1.1040	0.6633	1.5555	1.5552	1.5557	0.7911	0.7911	24.8534
1177 - 5	23.2007	11.6003	11.6003	2.2517	1.1252	1.1265	1.1043	0.6640	1.5565	1.5566	1.5567	0.7913	0.7913	24.8526
1177 - 11	23.2003	11.6001	11.6001	2.2512	1.1263	1.1249	1.1044	0.6646	1.5574	1.5551	1.5566	0.7916	0.7926	24.8483
1177 - 17	23.2003	11.6001	11.6001	2.2505	1.1265	1.1240	1.1060	0.6656	1.5569	1.5561	1.5561	0.7928	0.7912	24.8476
Extra #1	23.2060	11.6030	11.6030	2.2510	1.1223	1.1287	1.1090	0.6641	1.6145	1.6125	1.6132	0.8495	0.8525	24.9166
Extra #2	23.2058	11.6029	11.6029	2.2512	1.1281	1.1231	1.1072	0.6631	1.5629	1.5599	1.5578	0.7980	0.7964	24.8574

Note: Shaded data indicate a value out of specification.

Table 3. Dimensional Data for the Holes and Radii of Randomly Selected Laminates

Laminate	Hole 1	Hole 2	Hole 3	Hole 4	Rad. 3	Rad. 4	Rad. 5	Rad. 6	Rad. 7	Rad. 8	Rad. 9	Rad. 10	Rad. 11	Rad. 12
Specification Tolerance	0.6883 +0.0002 -0.0003	0.6883 +0.0002 -0.0003	0.1955 ±0.0005	0.1955 ±0.0005	0.82 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	2.00 ±0.03	0.82 ±0.03
1172 - 7	0.6876	0.6871	0.1941	0.1940	0.8270	1.9290	1.9626	2.0030	1.9692	1.8446	1.8539	1.9981	1.9854	0.8276
1172 - 16	0.6868	0.6866	0.1944	0.1942	0.8244	2.0484	1.8565	1.9534	1.9709	1.9519	1.9043	1.9029	1.9606	0.8283
1172 - 21	0.6872	0.6868	0.1938	0.1944	0.8247	2.0259	1.8329	1.8933	1.9754	1.8884	1.9040	1.8360	2.0176	0.8239
1173 - 2	0.6874	0.6869	0.1922	0.1941	0.8226	1.9733	1.7778	2.0883	1.9952	2.0374	1.9157	1.9600	2.0074	0.8251
1173 - 9	0.6829	0.6871	0.1937	0.1941	0.8258	1.9425	1.8803	1.9941	1.9497	1.9171	1.9541	1.9042	1.9354	0.8257
1173 - 19	0.6874	0.6866	0.1942	0.1942	0.8254	2.0131	2.1237	1.9602	1.9923	1.9126	1.8791	1.8790	2.0036	0.8253
1167 - 1	0.6873	0.6872	0.1942	0.1942	0.8291	2.0871	2.0342	1.9137	1.9892	2.1128	1.9768	2.0107	1.9742	0.8270
1167 - 8	0.6877	0.6875	0.1930	0.1943	0.8250	1.9683	2.0187	1.9850	2.0251	2.0125	1.9752	1.9662	2.0049	0.8267
1167 - 20	0.6878	0.6877	0.1947	0.1949	0.8269	1.8214	1.8887	1.9344	2.0394	2.0157	2.0227	1.9634	1.9666	0.8275
1169 - 2	0.6874	0.6869	0.1930	0.1941	0.8298	1.9752	1.9645	1.9998	1.9574	2.0285	1.8977	2.0209	1.9634	0.8263
1169 - 13	0.6868	0.6865	0.1928	0.1939	0.8243	2.0019	1.8545	1.9458	1.9964	1.8848	1.8622	1.9823	1.9772	0.8256
1169 - 22	0.6876	0.6873	0.1973	0.1932	0.8293	1.9515	1.9164	1.9305	1.9391	1.8502	1.8860	1.9524	1.9291	0.8249
1168 - 2	0.6876	0.6869	0.1947	0.1944	0.8262	1.9409	1.8675	1.9612	2.0046	1.9869	1.9440	1.9150	1.9976	0.8265
1168 - 12	0.6872	0.6878	0.1943	0.1941	0.8264	2.0093	1.8277	1.9816	1.9938	1.9698	1.9213	1.9549	1.9989	0.8296
1168 - 20	0.6877	0.6868	0.1942	0.1941	0.8306	1.9896	1.9602	1.9614	2.0111	1.9938	1.9131	1.8419	1.9830	0.8272
1174 - 4	0.6871	0.6873	0.1945	0.1939	0.8308	1.9845	1.9764	1.9378	1.9965	1.9691	1.8404	1.8854	1.9940	0.8263
1174 - 11	0.6878	0.6874	0.1946	0.1945	0.8262	2.0329	1.8427	1.9972	1.9932	1.9673	1.9593	1.9449	1.9822	0.8237
1174 - 20	0.6873	0.6870	0.1935	0.1941	0.8270	1.9331	1.8613	1.9042	1.9365	2.0350	1.8910	1.9486	1.9658	0.8260
1175 - 1	0.6863	0.6875	0.1948	0.1947	0.8257	1.8775	1.9290	1.9699	1.9482	2.0053	1.9175	1.9006	1.9907	0.8239
1175 - 12	0.6871	0.6873	0.1941	0.1944	0.8235	2.0131	1.8561	1.8926	1.9780	2.0203	1.9513	1.9262	1.9812	0.8269
1175 - 19	0.6870	0.6871	0.1943	0.1936	0.8260	1.9234	1.8671	2.0540	1.9908	1.9741	1.8698	2.0340	2.0055	0.8285
1176 - 3	0.6882	0.6881	0.1948	0.1947	0.8277	1.9827	2.0540	1.8037	2.0052	1.9236	1.9234	2.0219	2.0085	0.8283
1176 - 10	0.6871	0.6871	0.1925	0.1936	0.805	2.0038	2.0969	1.9254	2.0123	1.9922	1.8580	1.8446	2.0432	0.8236
1176 - 21	0.6873	0.6865	0.1932	0.1935	0.8243	2.0758	1.6509	1.9837	1.9400	1.9477	1.9817	1.9098	1.9746	0.8286
1177 - 5	0.6876	0.6863	0.1935	0.1937	0.8250	1.9244	2.0392	1.9729	1.9815	1.9178	1.9123	1.8865	1.9592	0.8269
1177 - 11	0.6871	0.6876	0.1941	0.1942	0.8231	1.9437	1.9414	1.9728	2.0209	1.9946	1.9038	1.9012	1.9868	0.8249
1177 - 17	0.6872	0.6867	0.1939	0.1919	0.8240	1.9174	1.9714	1.9568	1.9662	1.9504	1.8684	1.9497	2.0015	0.8233
Extra #1	0.6849	0.6864	0.1934	0.1939	0.8535	1.9737	1.9599	2.0032	1.8058	1.9664	1.9715	1.9674	1.9464	0.8571
Extra #2	0.6872	0.6867	0.1931	0.1935	0.8242	1.9839	2.0143	1.9860	1.9847	1.9881	1.9779	1.9673	1.9788	0.8274

Note: Shaded data indicates a value out of specification.

Table 4. Dimensional Examination of Laminate Set 1174

Laminate	DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	DIM. F	DIM. G	DIM. H	DIM. I	DIM. J	DIM. K	DIM. L	DIM. M	DIM. N
Specification Tolerance	23.200 ±0.010	11.600 ±0.010	11.600 ±0.010	2.250 ±0.010	1.125 ±0.010	1.125 ±0.010	1.100 ±0.010	0.660 ±0.010	1.550 ±0.010	1.550 ±0.010	1.550 ±0.010	0.790 ±0.010	0.790 ±0.010	24.840 REF.
1174-1	23.2001	11.6005	11.6005	2.2513	1.1249	1.1263	1.1053	0.6635	1.5544	1.5564	1.5560	0.7903	0.7912	24.8483
1174-2	23.2014	11.6007	11.6007	2.2508	1.1246	1.1262	1.1061	0.6653	1.5532	1.5555	1.5543	0.7907	0.7922	24.8500
1174-3	23.2011	11.6005	11.6005	2.2508	1.1245	1.1264	1.1058	0.6608	1.5567	1.5572	1.5561	0.7909	0.7908	24.8561
1174-4	23.2018	11.6009	11.6009	2.2517	1.1254	1.1266	1.1063	0.6657	1.5549	1.5559	1.5564	0.7902	0.8221	24.8568
1174-5	23.2017	11.6008	11.6008	2.2511	1.1248	1.1263	1.1057	0.6635	1.5557	1.5573	1.5574	0.7912	0.7914	24.8519
1174-6	23.2012	11.6006	11.6006	2.2513	1.1249	1.1263	1.1052	0.6641	1.5554	1.5554	1.5563	0.7902	0.7904	24.8512
1174-7	23.2015	11.6007	11.6007	2.2507	1.1247	1.1261	1.1059	0.6662	1.5549	1.5571	1.5553	0.7901	0.7883	24.8440
1174-8	23.2016	11.6008	11.6008	2.2512	1.1254	1.1257	1.1054	0.6643	1.5563	1.5509	1.5572	0.7901	0.7905	24.8481
1174-9	23.2013	11.6006	11.6006	2.2511	1.1253	1.1257	1.1050	0.6646	1.5558	1.5566	1.5576	0.7908	0.7914	24.8559
1174-10	23.2014	11.6007	11.6007	2.2509	1.1251	1.1258	1.1042	0.6636	1.5567	1.5578	1.5583	0.7907	0.7905	24.8534
1174-11	23.2009	11.6004	11.6004	2.2504	1.1248	1.1256	1.1055	0.6655	1.5559	1.5563	1.5575	0.7897	0.7923	24.8440
1174-12	23.2017	11.6008	11.6008	2.2516	1.1264	1.1252	1.1046	0.6646	1.5564	1.5578	1.5577	0.7925	0.7893	24.8561
1174-13	23.2011	11.6005	11.6005	2.2509	1.1259	1.1250	1.1057	0.6649	1.5559	1.5578	1.5563	0.7913	0.7908	24.8486
1174-14	23.2011	11.6005	11.6005	2.2510	1.1260	1.1250	1.1050	0.6637	1.5568	1.5547	1.5577	0.7915	0.7924	24.8507
1174-15	23.2011	11.6005	11.6005	2.2514	1.1262	1.1253	1.1048	0.6643	1.5569	1.5582	1.5580	0.7910	0.7947	24.8589
1174-16	23.1966	11.5893	11.5893	2.2506	1.1270	1.1240	1.1038	0.6643	1.5567	1.5575	1.5582	0.7923	0.7917	24.8457
1174-17	23.2008	11.6004	11.6004	2.2505	1.1247	1.1258	1.1052	0.6649	1.5569	1.5576	1.5570	0.7903	0.7923	24.8544
1174-18	23.2002	11.6001	11.6001	2.2513	1.1249	1.1263	1.1053	0.6648	1.5557	1.5569	1.5569	0.7913	0.7915	24.8524
1174-19	23.2008	11.6004	11.6004	2.2510	1.1256	1.1254	1.1042	0.6635	1.5566	1.5580	1.5569	0.7920	0.7928	24.8462
1174-20	23.2009	11.6004	11.6004	2.2507	1.1248	1.1259	1.1034	0.6641	1.5565	1.5579	1.5582	0.7915	0.7921	24.8413
1174-21	23.2023	11.6011	11.6011	2.2507	1.1252	1.1255	1.1044	0.6639	1.5561	1.5576	1.5568	0.7929	0.7936	24.8536
1174-22	23.2008	11.6004	11.6004	2.2507	1.1248	1.1258	1.1041	0.6652	1.5567	1.5578	1.5563	0.7916	0.7921	24.8494

Laminate	Hole 1	Hole 2	Hole 3	Hole 4	Rad. 1	Rad. 2	Rad. 3	Rad. 4	Rad. 5	Rad. 6	Rad. 7	Rad. 8	Rad. 9	Rad. 10	Rad. 11	Rad. 12
Specification Tolerance	0.6883 +0.0002 -0.0003	0.6883 +0.0002 -0.0003	0.1955 • 0.0005	0.1955 • 0.0005	0.33 • 0.03	0.33 • 0.03	0.82 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	0.82 • 0.03
1174-1	0.6871	0.6869	0.1938	0.1942	0.3289	0.3305	0.8226	1.9778	1.9626	1.9245	1.9559	1.8808	1.9280	1.8864	2.0028	0.8248
1174-2	0.6877	0.6877	0.1946	0.1950	0.3296	0.3307	0.8248	1.9669	1.8944	1.9274	1.9603	1.9696	1.9233	1.9246	1.9775	0.8237
1174-4	0.6873	0.6876	0.1946	0.1950	0.3295	0.3307	0.8255	1.9691	1.9481	1.8962	2.0025	1.9648	1.9504	1.7209	1.9754	0.8295
1174-5	0.6871	0.6868	0.1938	0.1935	0.3292	0.3287	0.8239	1.9844	1.7876	1.9239	1.8002	1.9697	1.9076	1.8746	1.9638	0.8263
1174-6	0.6865	0.6872	0.1953	0.1946	0.3310	0.3298	0.8226	2.0348	1.8665	1.8988	1.9731	1.8771	1.8587	2.0432	2.0006	0.8374
1174-7	0.6875	0.6876	0.1941	0.1946	0.3295	0.3295	0.8199	1.9737	1.9834	2.0130	1.9894	1.9914	1.8843	1.8596	2.0018	0.8226

Note: Shaded data indicates values out of specification.

Table 4. Dimensional Examination of Laminate Set 1174 (continued)

Laminate	Hole 1	Hole 2	Hole 3	Hole 4	Rad. 1	Rad. 2	Rad. 3	Rad. 4	Rad. 5	Rad. 6	Rad. 7	Rad. 8	Rad. 9	Rad. 10	Rad. 11	Rad. 12
Specification Tolerance	0.6883 + 0.0002 - 0.0003	0.6883 + 0.0002 - 0.0003	0.1955 • 0.0005	0.1955 • 0.0005	0.33 • 0.03	0.33 • 0.03	0.82 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	2.00 • 0.03	0.82 • 0.03
1174-8	0.6870	0.6871	0.1939	0.1941	0.3283	0.3293	0.8224	1.9471	1.9277	1.9019	1.8591	1.9482	1.8789	1.8724	1.9687	0.8241
1174-9	0.6869	0.6869	0.1942	0.1940	0.3329	0.3287	0.8268	1.9584	2.0757	1.9858	1.9781	1.8931	1.8644	1.9371	2.0004	0.8278
1174-10	0.6865	0.6871	0.1935	0.1938	0.3297	0.3295	0.8259	1.9833	1.9261	1.8952	1.9761	1.9626	1.9568	1.8917	2.0209	0.8262
1174-11	0.6876	0.6877	0.1947	0.1941	0.3292	0.3295	0.8240	2.0396	1.8954	1.9821	1.9799	1.9881	1.9061	1.9543	1.4613	0.8191
1174-12	0.6872	0.6871	0.1945	0.1943	0.3298	0.3257	0.8272	1.9296	1.9014	1.7965	1.9882	1.9612	1.9818	1.9082	2.0327	0.8283
1174-13	0.6883	0.6879	0.1948	0.1954	0.3289	0.3307	0.8239	1.9127	2.0271	1.9636	1.9630	1.9633	1.9113	1.8245	2.0155	0.8236
1174-14	0.6869	0.6867	0.1937	0.1936	0.3287	0.3287	0.8228	2.0057	1.8107	1.8897	1.9843	1.9420	1.9199	1.8668	1.9617	0.8268
1174-15	0.6869	0.6870	0.1938	0.1934	0.3287	0.3287	0.8325	1.9796	1.8559	1.9554	1.9573	1.9908	2.0639	1.9814	1.9854	0.8253
1174-16	0.6826	0.6872	0.1938	0.1941	0.3298	0.3289	0.8211	2.0155	1.9128	1.9569	1.9984	1.9399	1.9248	1.9328	1.9814	0.8280
1174-17	0.6872	0.6875	0.1945	0.1941	0.3290	0.3292	0.8273	1.9687	2.0025	1.8415	2.0244	1.8908	1.9124	1.9128	1.8559	0.8262
1174-18	0.6883	0.6872	0.1948	0.1952	0.3296	0.3204	0.8263	1.9597	1.9260	1.9520	1.9455	1.9574	1.9639	1.9621	2.0013	0.8259
1174-19	0.6873	0.6872	0.1939	0.1940	0.3292	0.3221	0.8266	1.9341	1.9488	1.9399	1.9524	1.9600	1.9864	1.9404	1.9963	0.8227
1174-20	0.6867	0.6869	0.1939	0.1941	0.3298	0.3310	0.8176	2.0006	1.9381	1.9526	1.9688	1.9945	1.8490	1.9313	1.9854	0.8228
1174-21	0.6873	0.6871	0.1942	0.1943	0.3296	0.3257	0.8236	1.9386	1.9032	1.9882	1.9148	1.9211	2.0349	1.9259	2.0193	0.8243
1174-22	0.6872	0.6869	0.1942	0.1942	0.3304	0.3309	0.8269	1.9479	1.7793	1.8999	1.9991	1.9857	1.9446	1.8488	2.0402	0.8257

Note: Shaded data indicates values out of specification.

Therefore, one complete laminate set (SN 003343-1174, laminates 1–22) was dimensionally checked for conformance to the governing drawings. The results are listed in Table 4. Also, it was acutely apparent from the randomly selected laminates that a problem existed with the hole dimensions. The radii also appeared to be out of specification; however, the edge finishing of the laminates might be effecting these results as previously discussed. Regardless, the hole dimensions are much more critical from a stress analysis standpoint than the radii dimensions.

A 180° transposition about the Y-axis was not seen for any laminate within this laminate assembly set. It cannot be inferred from this investigation that the transposition of the laminates is either an abundant or infrequent occurrence. ARL-WMRD looked at only one complete laminate set, other than the QDR exhibits. A proper estimation of the frequency of this occurrence should be drawn from a larger population of laminate sets. However, the frequency with which the hole dimensions are out of specification (smaller than the acceptable value) is significant and distressing. Considering the hole diameters were found to be smaller than the acceptable values, the bushings and rivets must have been forced through these holes during assembly. The bushings and rivets are governed by specifications BP-7-211421028 and NAS-529, respectively [9, 10]. Forcing the rivets through small holes would place undo stresses on the edges of the hole as well as the bushings and rivets. If the bushings and rivets must be forced in place, it could contribute to the buckling condition based on the assumption that the hole tolerances were probably set to allow for imperfections in part symmetry. If the holes are too small, individual laminates are forced to positions that may or may not align with the other laminates. This concept is depicted in Figure 8. In addition, creating stress concentrations on the inner diameters of these holes as well as the bushings and rivets might lead to serious problems for parts under fatigue loading conditions.

The laminates were also checked for conformance with EPB-4-321. No discrepancies or nonconformances with the specification were found. The surface finishes were all within 2–4 Ra, which was well within the specified 8 Ra. Appendices A–D present the data acquired on the edge finishing for the individual laminates of the sets analyzed. Strap packs 0899 and 1548, were examined, in addition to the three randomly selected laminates from each laminate set, the

two extra laminates, and the one complete laminate set 1174. The data were acquired from an image analysis system equipped with a CCD camera. The values obtained are based on a calibration performed on the laminates and are accurate only to one decimal place. The interior hole edge finishing data could not be acquired due to the small size of the holes. A boroscope small enough to acquire this data was not available. However, the edge finishes of all holes on all laminates were visually examined using optical microscopy techniques at 10×–65× magnification. Although no measurements could be taken, ARL-MD verified that all hole edges appeared properly broken and no discrepancies were observed.

5. Metallography

A representative longitudinal and transverse section of the strap pack laminates from 0899 and 1548 were mounted and metallographically prepared. The specimens were mounted in Bakelite with edge retention and rough-polished with 180–600-grit silicon carbide paper. Fine-polishing was accomplished with hand-polishing wheels using 3-μm and 1-μm diamond suspensions. Final polishing was performed with a vibratory unit and 0.06-μm colloidal silica. The as-polished specimens exhibited no significant inclusions per ASTM-E-45 [11].

The polished specimens were subsequently etched with Vilella's Reagent to reveal the resultant microstructure. The longitudinal and transverse sections of this semiaustenitic stainless steel exhibited fine carbides uniformly distributed within a tempered martensitic structure as shown in Figures 9–12, respectively, for strap packs 1548 and 0899. The detrimental delta (free ferrite) phase was not apparent to any discernable degree. This structure is consistent with the prior heat treatment, cold rolling, and tempering schedule of the AM-355 precipitation hardenable stainless steel. The material conformed to the governing specification HMS 6-1073.

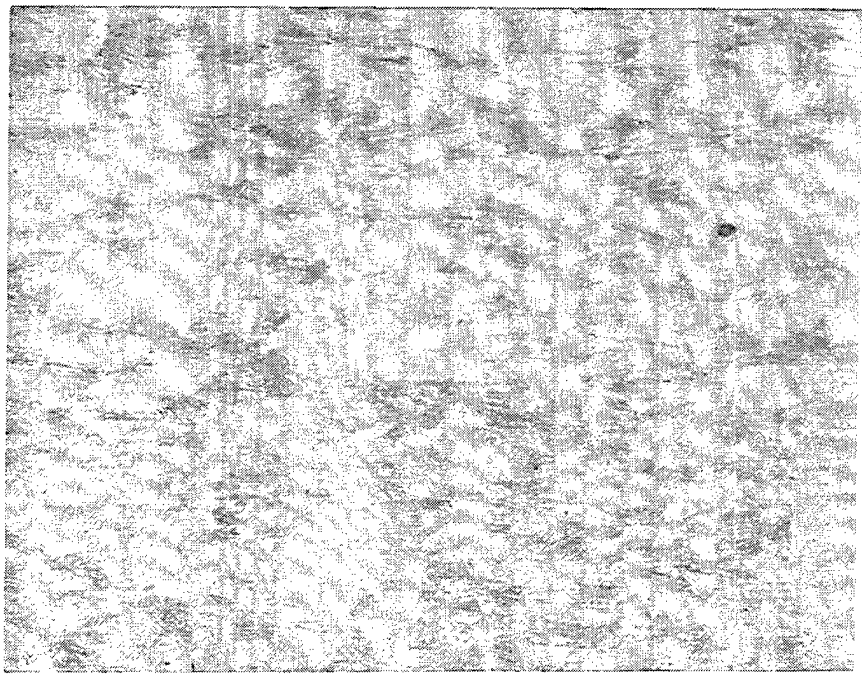

Figure 9. Micrograph of a Longitudinal Section of 1548. Vilella's Etch. Mag. 500×.

Figure 10. Micrograph of a Longitudinal Section of 0899. Vilella's Etch. Mag. 500×.

Figure 11. Micrograph of a Transverse Section of 1548. Vilella's Etch. Mag. 500×.

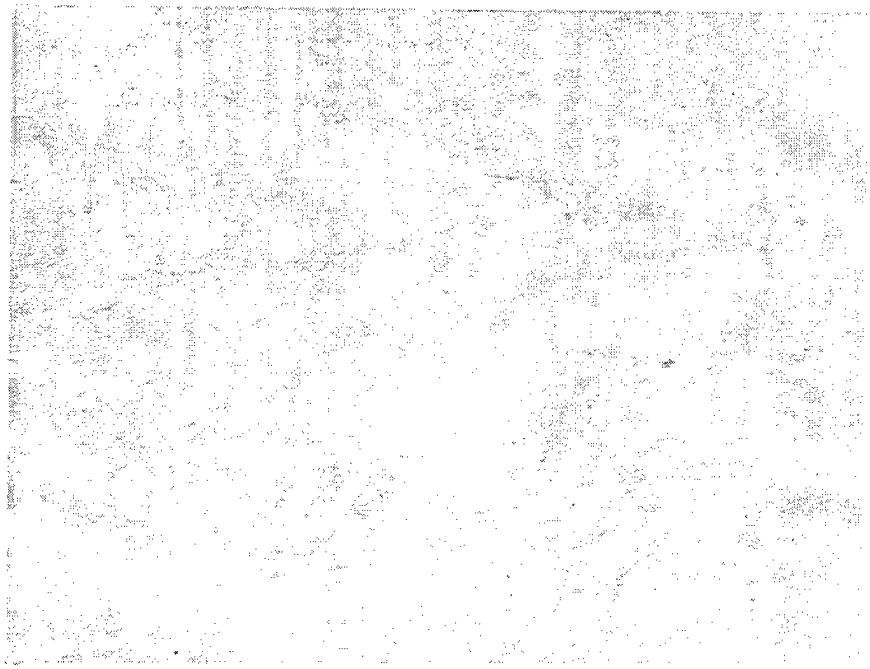

Figure 12. Micrograph of a Transverse Section of 0899. Vilella's Etch. Mag. 500×.

6. Conclusions

The examination revealed that, for the two assembly QDR exhibits, the buckling along the length was caused by a combination of controlling factors. The first being a dimensional nonconformity with respect to the hole diameters, and the second being a transposition about the Y-axis of the part that is not perfectly symmetric. All assembly laminates examined were found to have hole diameters smaller than allowed per the specified part drawing BP-7-211421023. The unassembled laminate sets were also examined and were found to contain the same dimensional nonconformity. The transposition of the respective positions of the laminates within the pack is prohibited after hole boring or reaming, per EPB-4-321, para. 3.3.1.3.1 [4]. However, considering the laminates may have the finishing operations performed individually or in subsets of the pack, a Y-axis transposition of a laminate with respect to its rotational orientation is most likely the root-cause of the buckling, since it is not distinctly prohibited per the specification (refer to the discussion section). All other characteristics of the laminates and assemblies were found to conform to the governing part drawings and specifications.

7. References

1. Lockheed Support Systems, Inc. "Quality Deficiency Report for Exhibit Part Number 7-211421035-5 and Serial Number 003343-0899." W81CL8940027, Fort Hood Army Airfield, Fort Hood, TX, 8 March 1994.

2. Lockheed Support Systems, Inc. "Quality Deficiency Report for Exhibit Part Number 7-211421035-5 and Serial Number 003343-1548." W81CL8940085, Fort Hood Army Airfield, Fort Hood, TX, 16 November 1994.

3. McDonnell Douglas Helicopter Company. "Strap Assembly - Tail Rotor." Drawing Package BP-7-211421035, 5000 East McDowell Road Mesa, AZ, 4 April 1991.

4. McDonnell Douglas Helicopter Company. "Finishing Holes, Edges, and Surfaces of AH-64 Main and Tail Rotor Blade Retention Laminates." Engineering Process Bulletin 4-321 (EPB-4-321), Revision E, 5000 East McDowell Road, Mesa, AZ, 3 June 1994.

5. McDonnell Douglas Helicopter Company. "Strap Assembly – Tail Rotor." Drawing Package BP-7-211421035, 5000 East McDowell Road Mesa, AZ, 4 April 1991.

6. McDonnell Douglas Helicopter Company. "Steel, Sheet and Strip, Corrosion Resistant, AM-355 CRT (Cold Rolled and Tempered)." Material Specification HMS-6-1073 Rev. E., 5000 East McDowell Road, Mesa, AZ, 9 January 1990.

7. McDonnell Douglas Helicopter Company. "Identification of Detail Parts and Assemblies." Process Specification HP 8-5 Rev. T, 5000 East McDowell Road, Mesa, AZ, 8 September 1993.

8. McDonnell Douglas Helicopter Company. "Serialization of Parts and Subassemblies, and Numbering for Material Control." Process Specification HP 8-8 Rev. E, 5000 East McDowell Road, Mesa, AZ, 29 November 1993.

9. McDonnell Douglas Helicopter Company. "Bushing, Tension-Torsion Strap, Tail Rotor." Drawing Package BP-7-211421028, 5000 East McDowell Road, Mesa, AZ, 2 October 1989.

10. National Aerospace Standards Committee, Aerospace Industry Association of America Inc. "Rivet-Flat Head, Hi-Shear, Close Tolerance Shank." National Aerospace Standard NAS-529, 1725 De Sales Street., NW, Washington, DC, 15 February 1983.

11. American Society for Testing and Materials, Standard Test Method ASTM-E-45. "Determining the Inclusion Content of Steel." 100 Barr Harbor Drive, West Conshohocken, PA, 1995.

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Appendix A:

Edge Break Data for Strap Pack 0899

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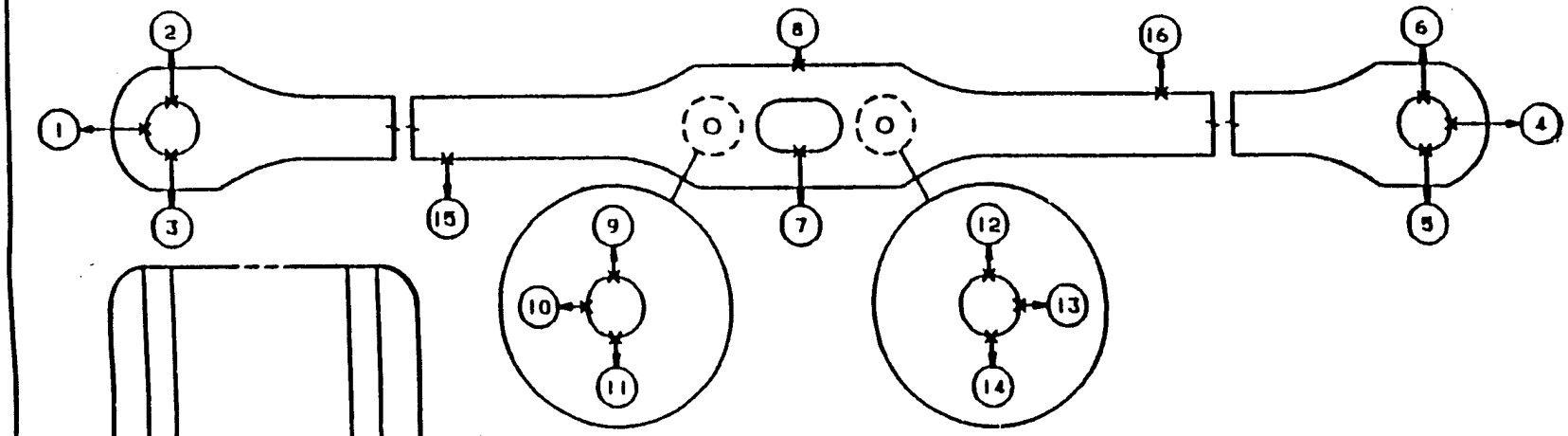
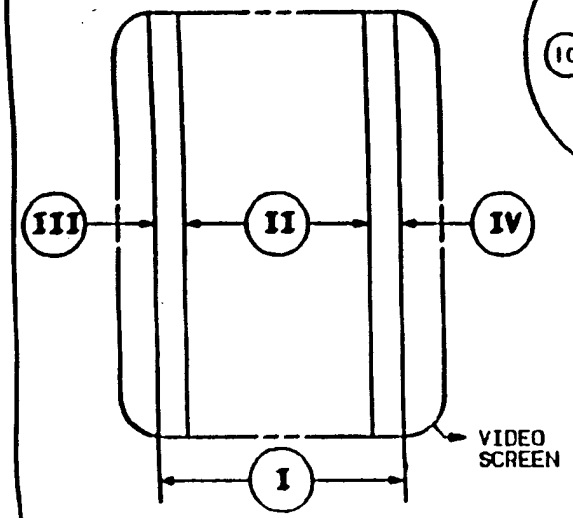
SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01385**
S/N **0899-1**





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

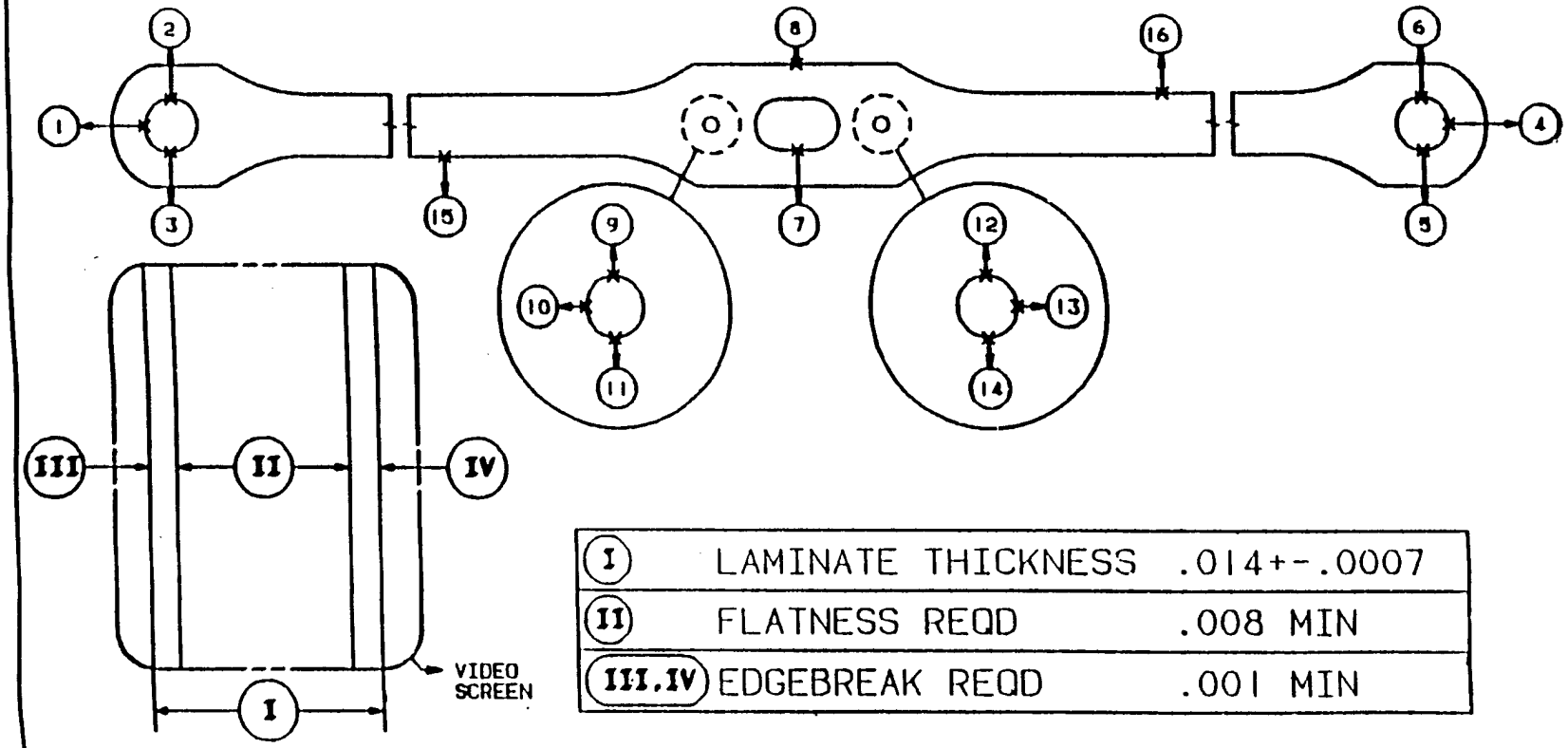
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.607	8.982							11.085	10.224
L - TOP							2.872	3.195							1.482	1.864
P - BOTTOM							1.362	2.224							1.374	1.929

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01381
S/N 0899-2



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

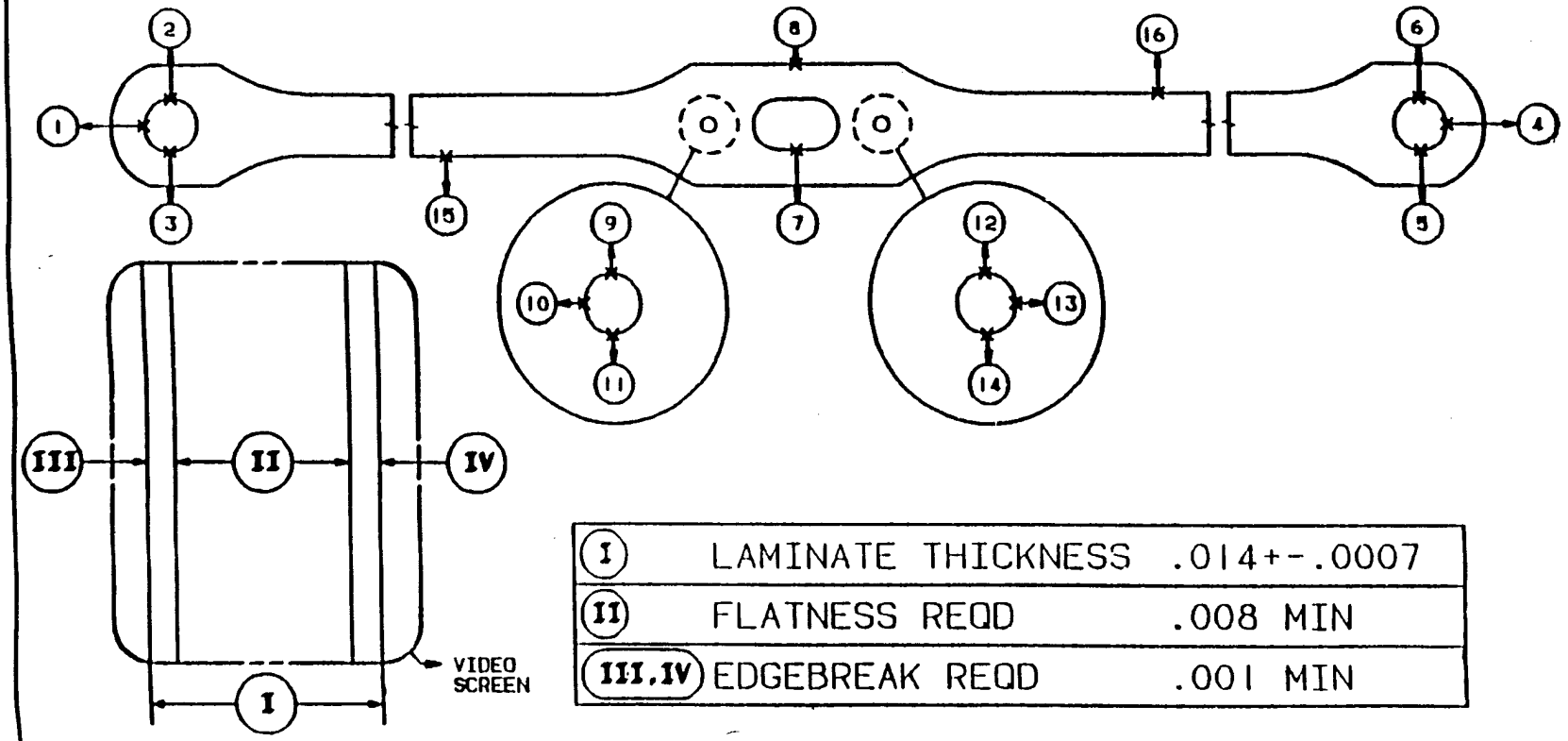
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.899	8.780							10.256	9.802
L - TOP							2.704	3.106							1.901	1.700
P - BOTTOM							1.973	2.038							1.901	2.116

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01360**
S/N **0899-3**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

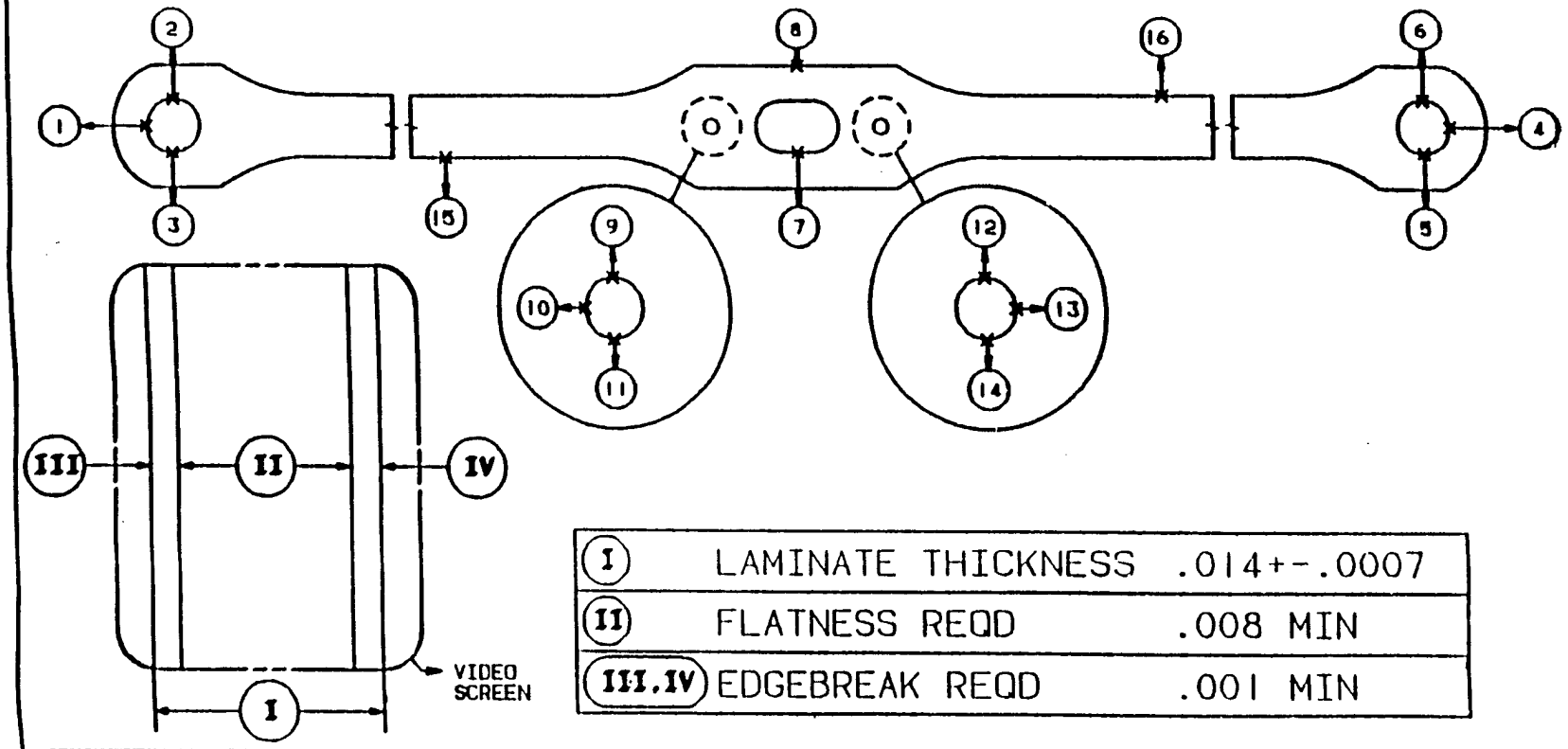
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.665	8.501							9.733	10.339
L - TOP							2.654	3.062							2.202	1.954
P - BOTTOM							1.929	2.441							1.864	1.581

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J. REDMAN	09/05/95

THICKNESS **0.01365**
S/N **0899-4**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

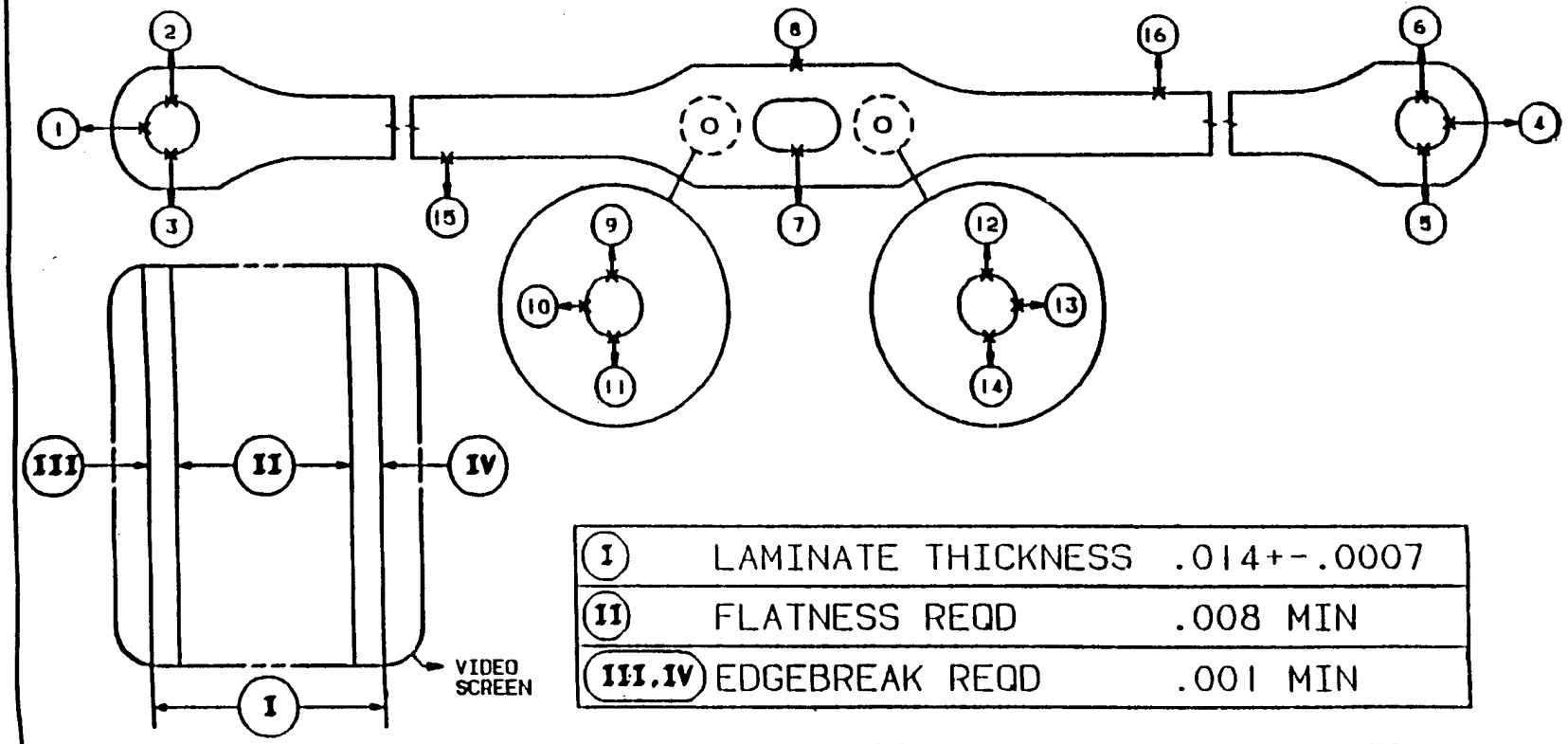
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.145	8.501							10.398	9.356
L - TOP							2.496	3.008							1.887	1.616
P - BOTTOM							1.995	2.183							1.837	1.983

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01381**
S/N **0899-5**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

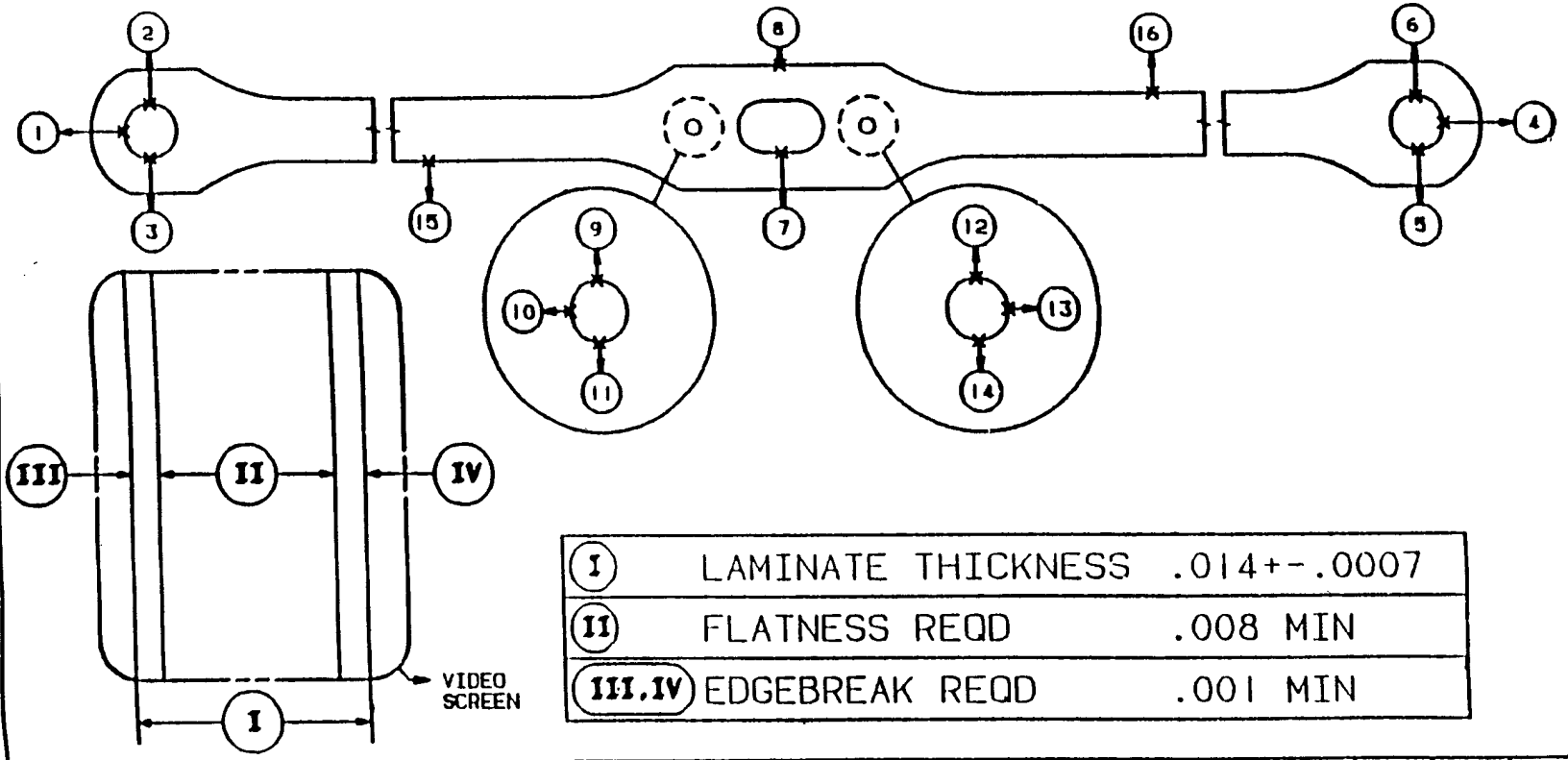
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.781	9.242							9.732	9.627
L - TOP							2.659	2.376							2.441	2.355
P - BOTTOM							2.332	2.062							2.076	2.038

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01375
S/N 0899-6 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

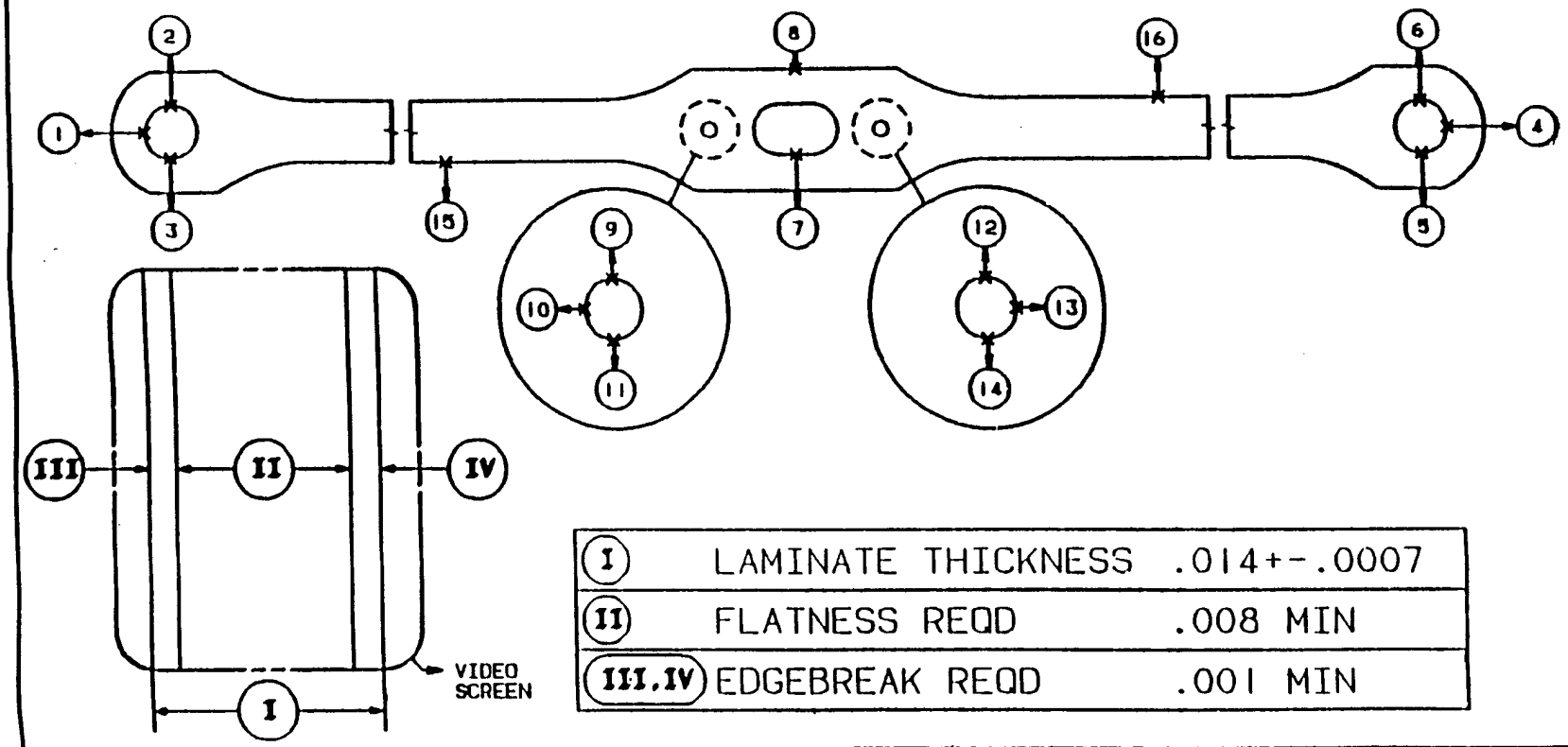
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.310	8.602							9.489	9.867
L - TOP							2.485	3.316							2.179	1.929
P - BOTTOM							1.901	2.116							2.320	2.183

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01370
S/N 0899-7 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

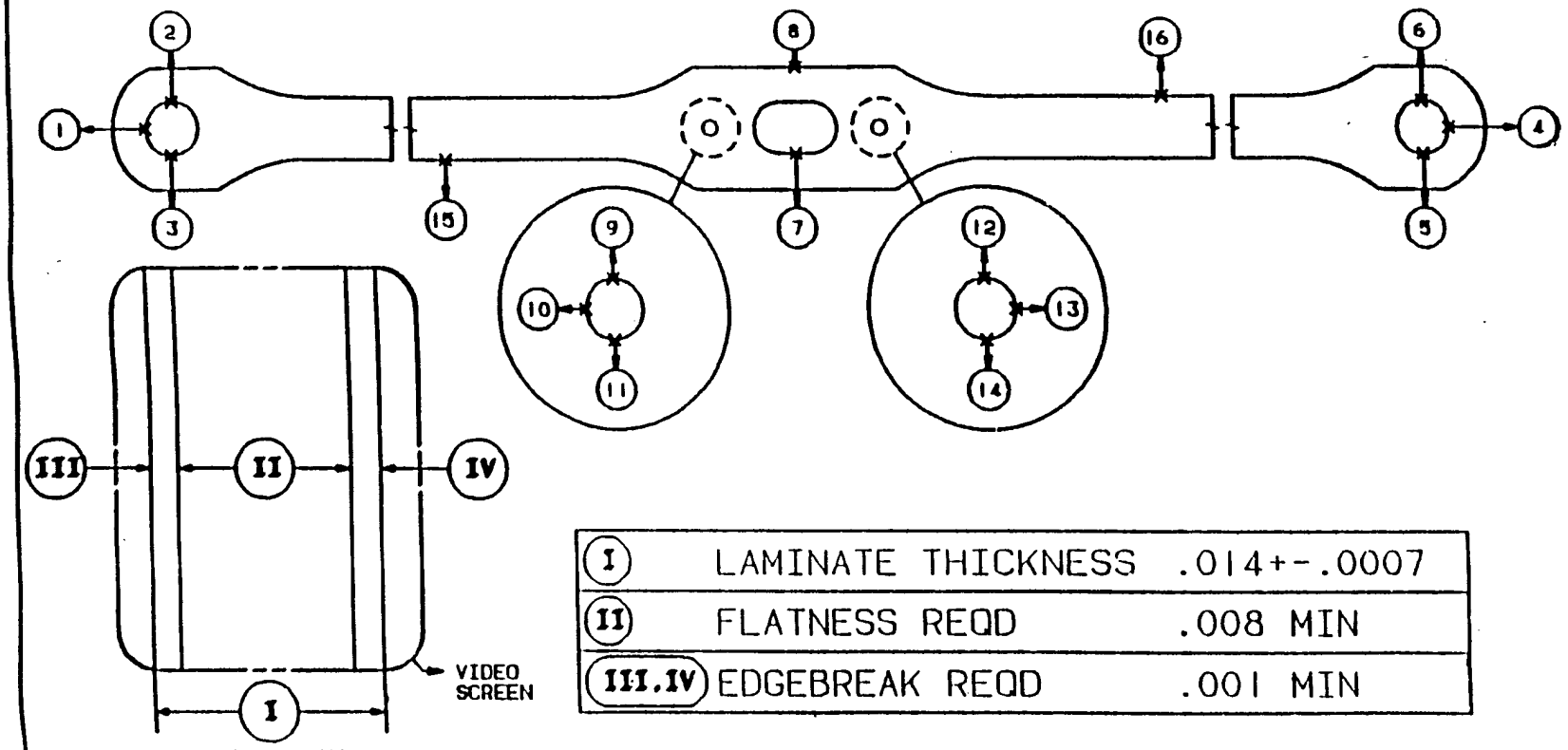
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.710	8.147							9.331	9.585
L - TOP							2.878	4.294							2.598	2.224
P - BOTTOM							2.062	1.537							1.833	2.183

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01380
S/N 0899-8



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

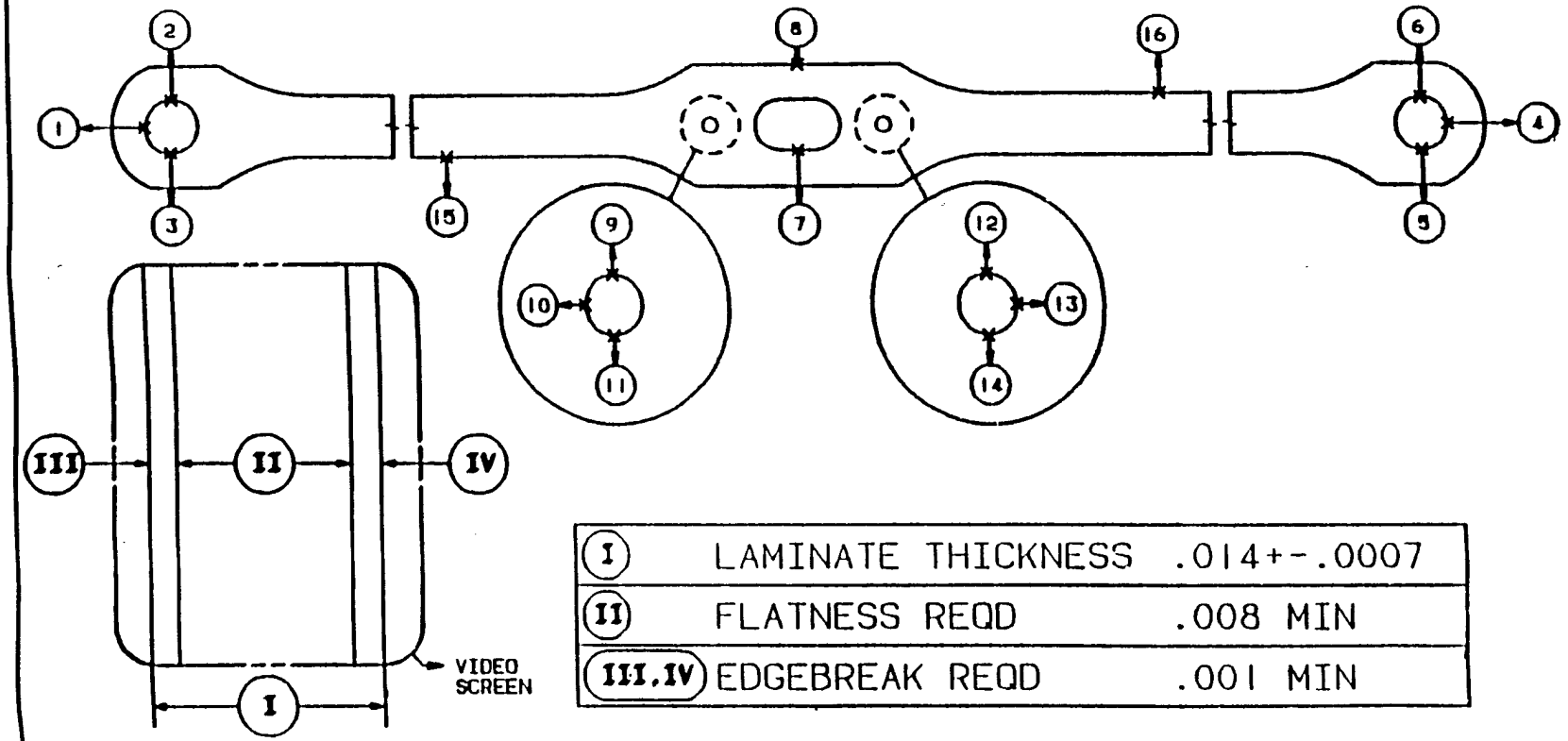
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.447	8.681							10.437	9.637
L - TOP							3.154	3.222							2.008	2.359
P - BOTTOM							2.161	2.345							1.565	2.032

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01366**
S/N **0899-9**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

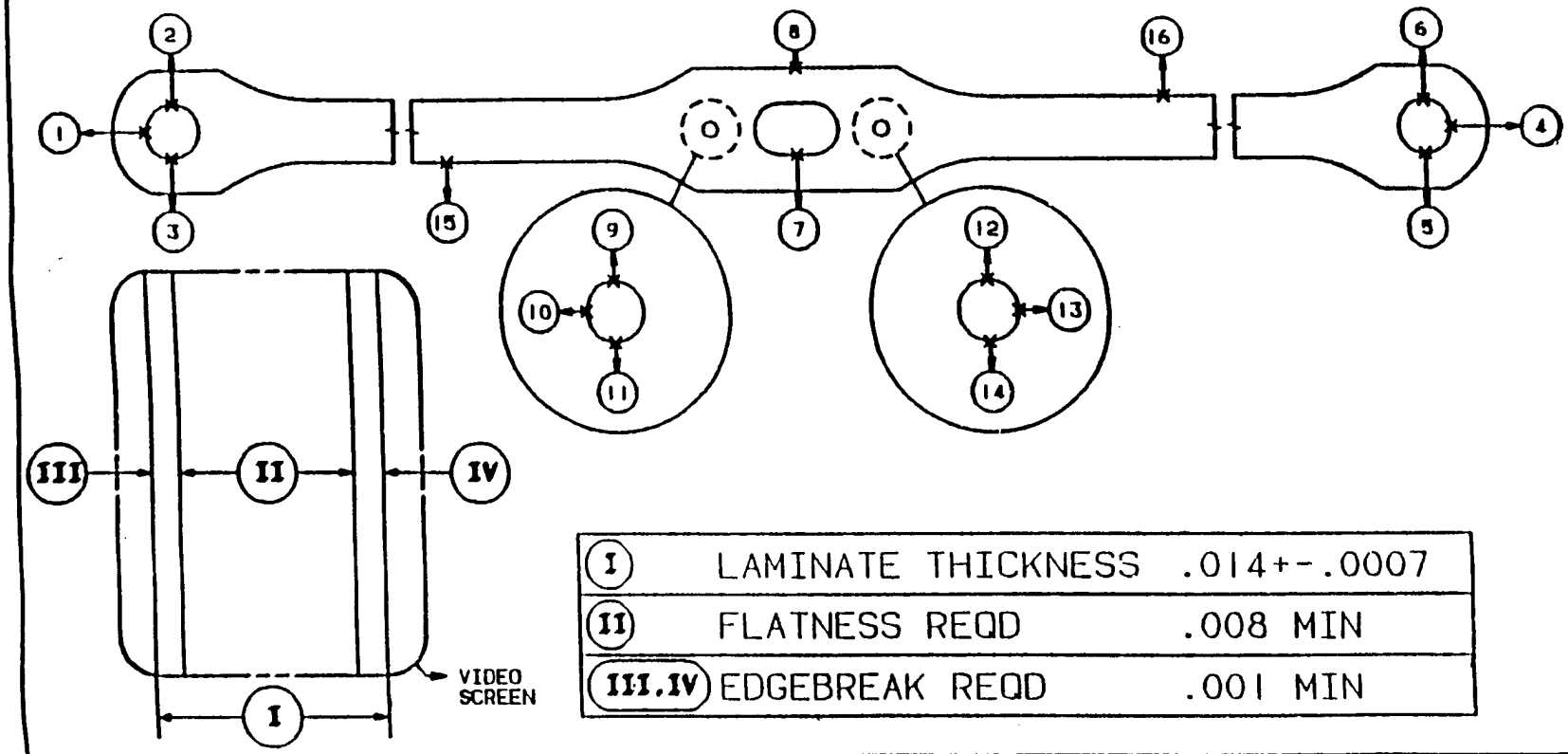
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.314	9.301							9.610	9.544
L - TOP							2.345	2.147							2.329	2.291
P - BOTTOM							1.874	2.252							2.237	2.237

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01386
S/N 0899-10



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

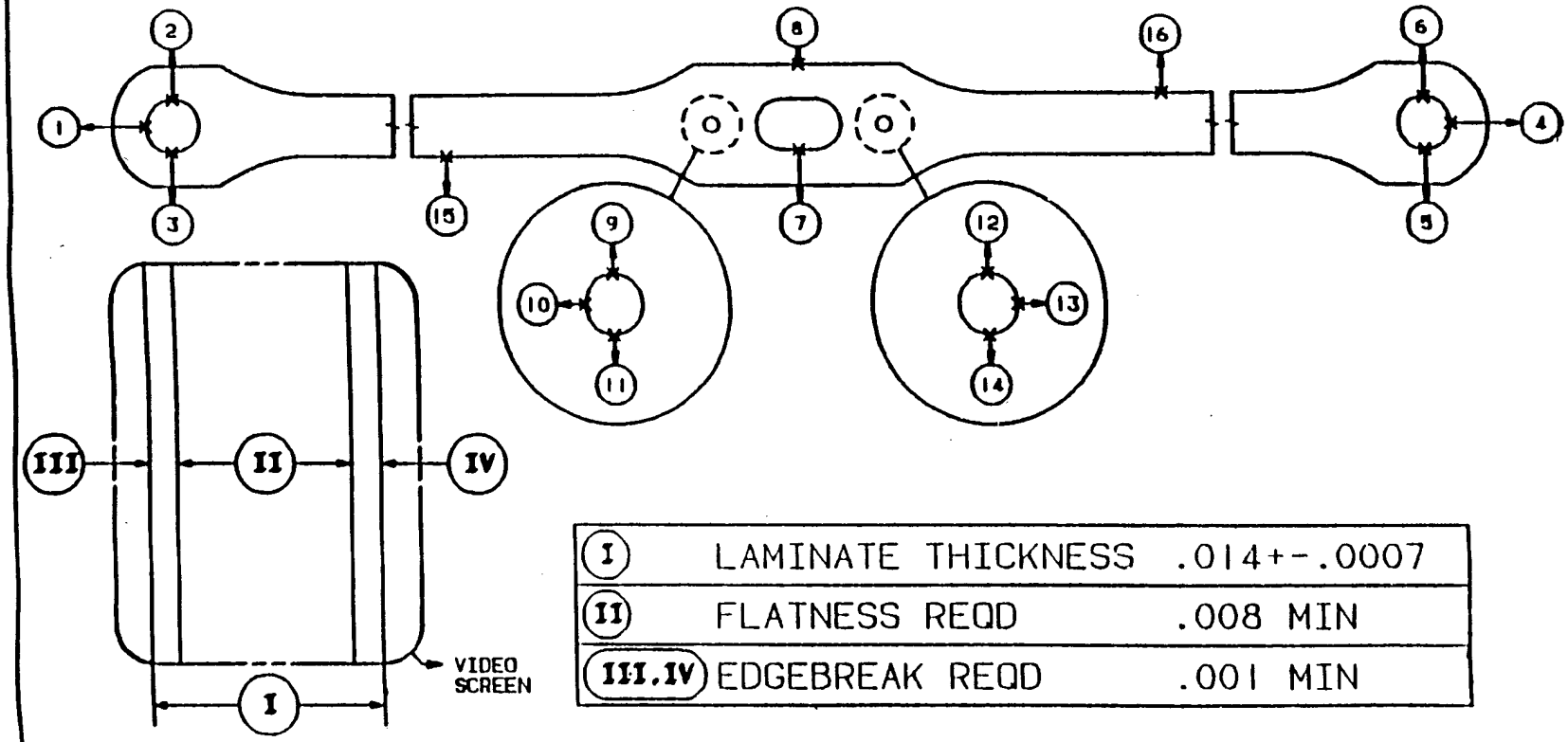
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.344	9.207							0.299	10.199
L - TOP							3.612	3.146							1.901	1.986
P - BOTTOM							1.618	1.828							2.198	2.030

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01376
S/N 0899-11



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

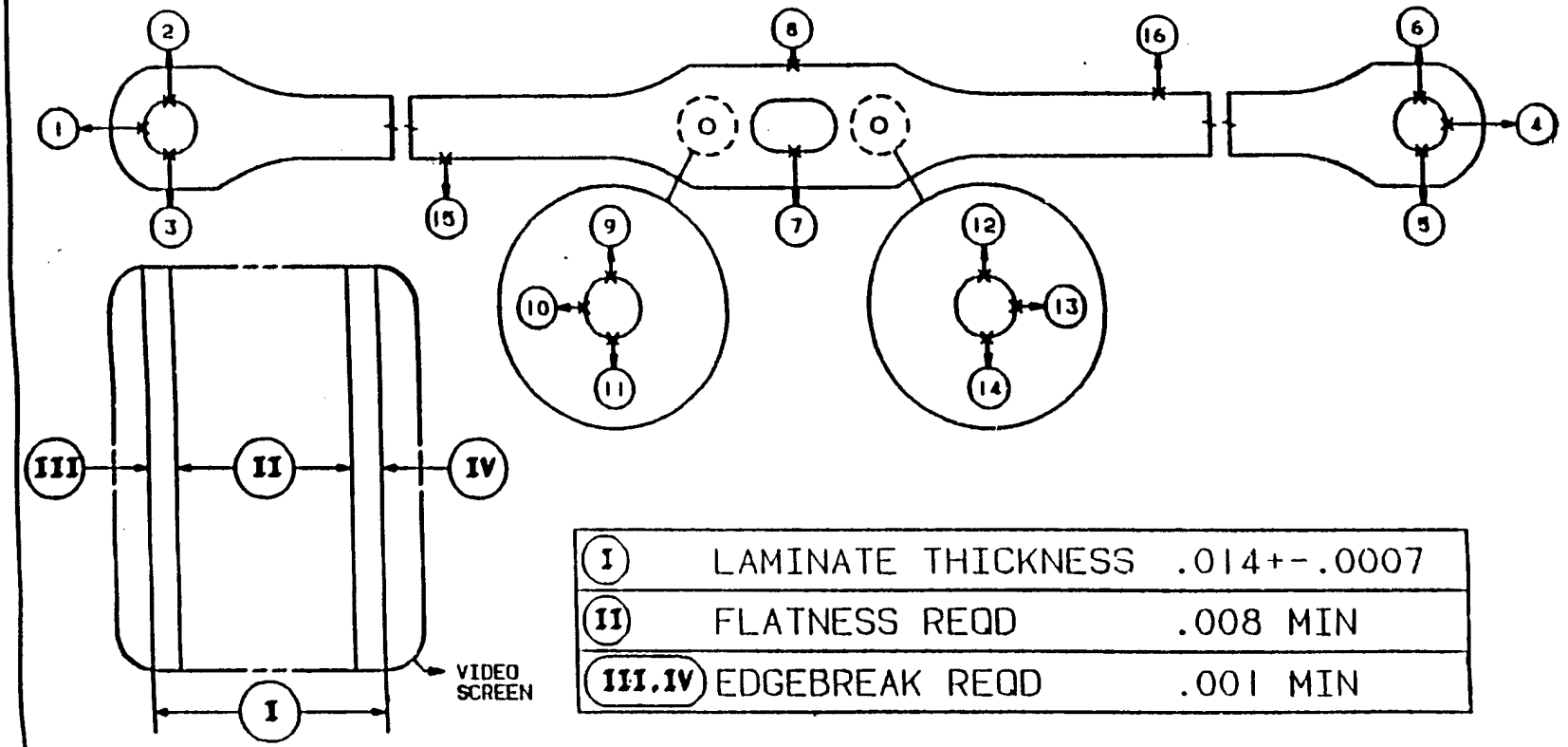
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.204	10.519							11.163	10.365
L - TOP							1.995	1.754							1.515	2.062
P - BOTTOM							1.645	2.224							1.267	1.794

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01370**
S/N **0899-12**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

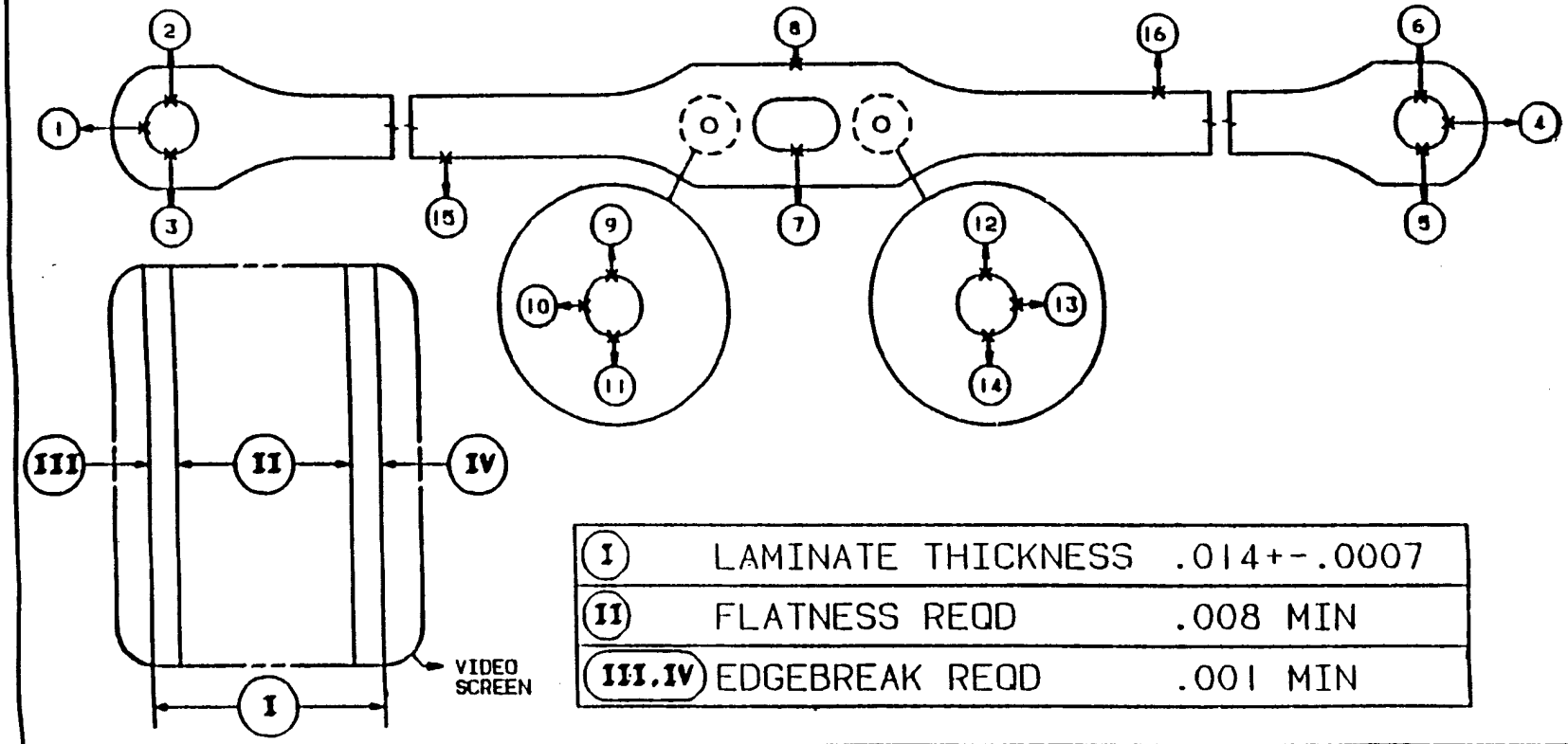
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.702	10.772							10.636	10.347
L - TOP							2.415	1.618							2.003	1.621
P - BOTTOM							2.446	1.712							1.197	1.873

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01370**
S/N **0899-13**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

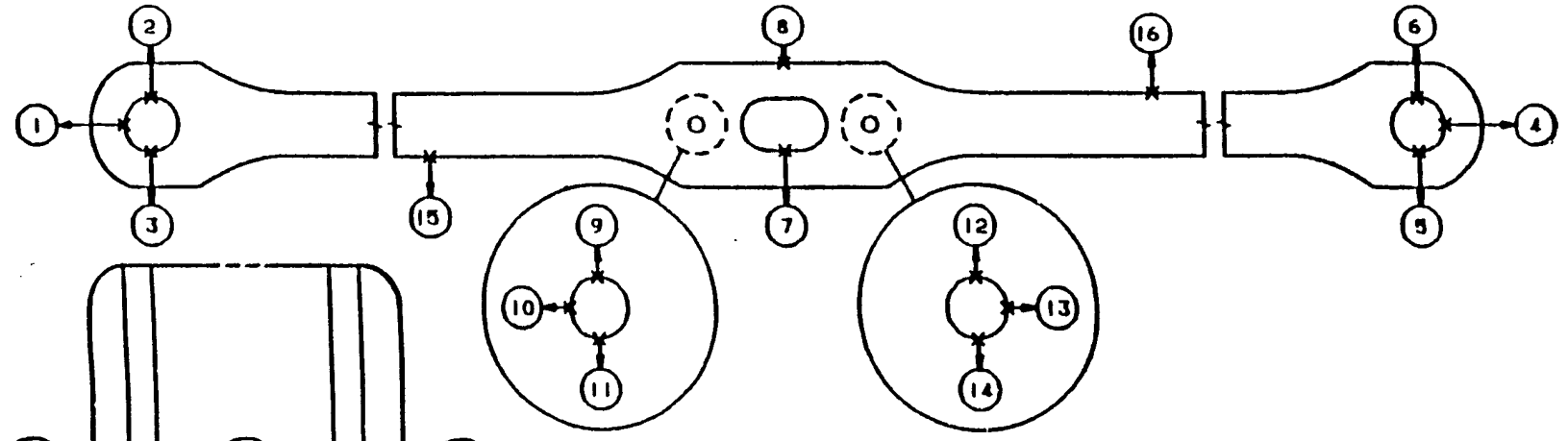
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.024	10.569							11.099	10.753
L - TOP							1.458	1.715							1.569	1.517
P - BOTTOM							1.321	1.343							1.321	1.269

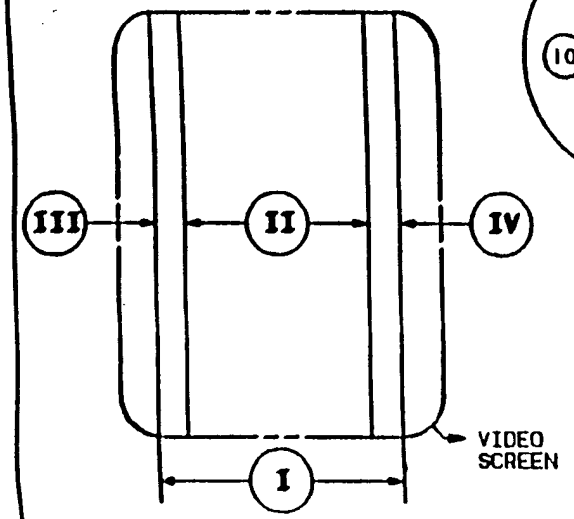
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01386
S/N 0899-14 -- _____





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

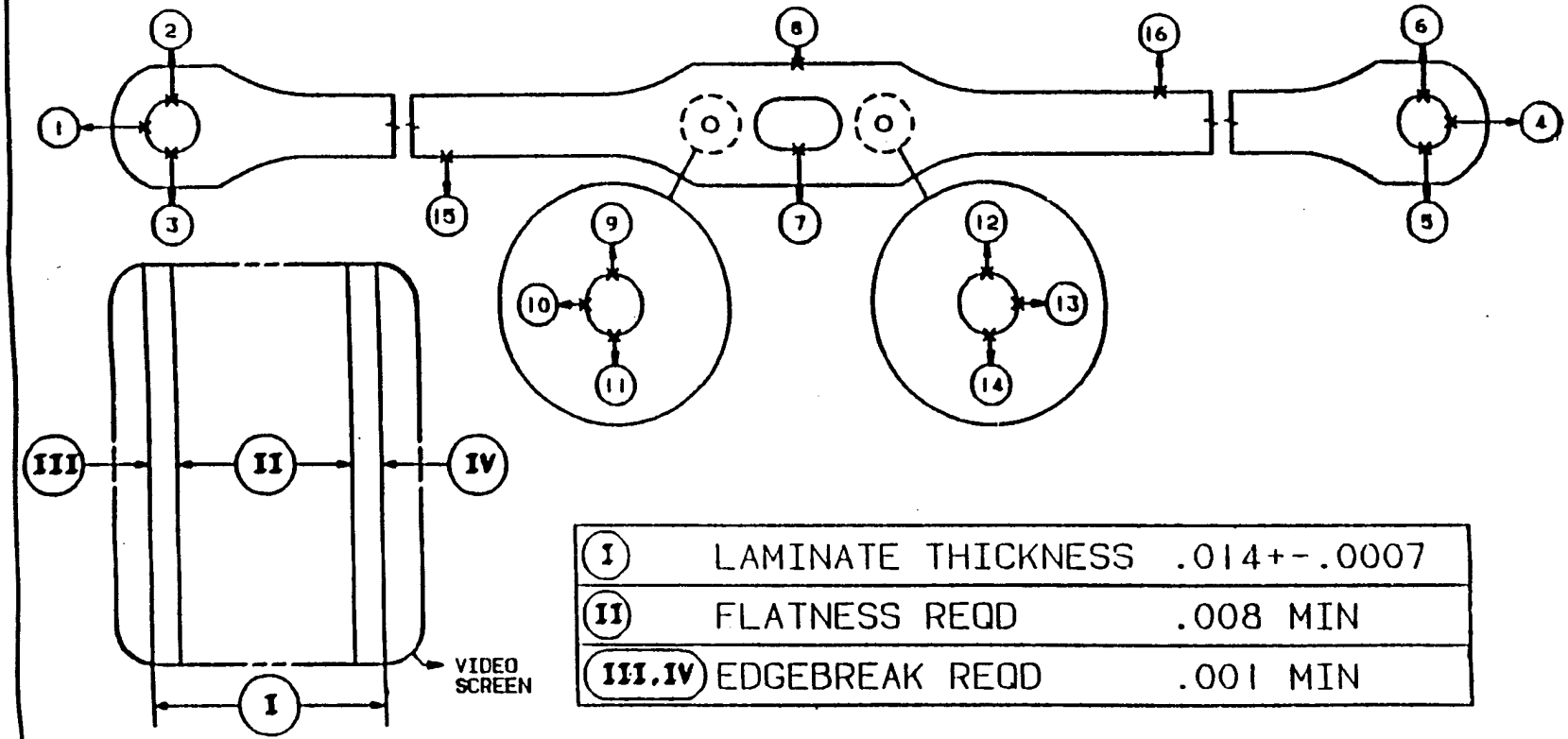
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.084	10.508							10.674	11.077
L - TOP							1.671	1.809							2.146	1.757
P - BOTTOM							1.372	1.635							1.860	1.125

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01385**
S/N **0899-15**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

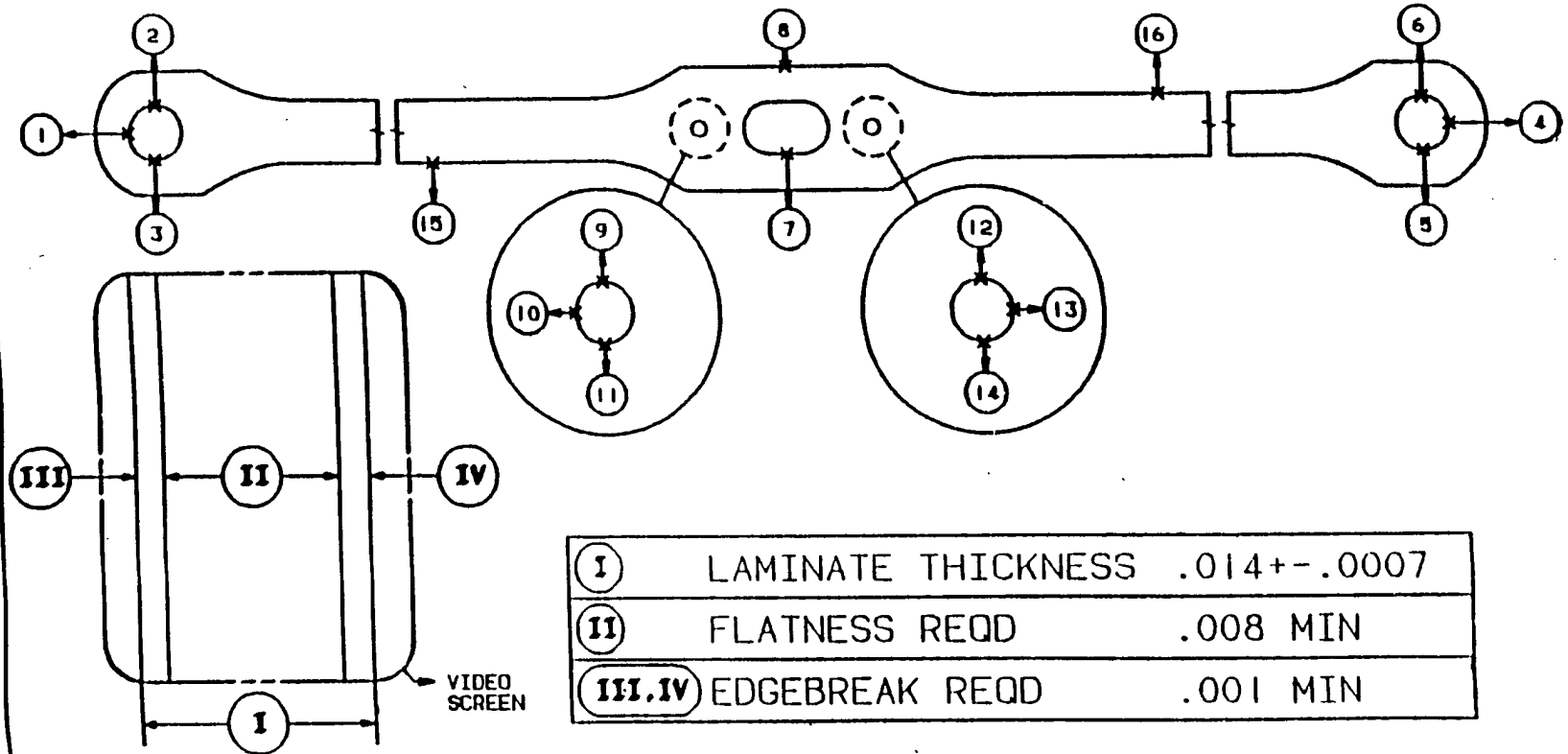
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.969	11.218							10.589	11.032
L - TOP							.992	1.419							.739	.723
P - BOTTOM							2.240	1.269							.569	.424

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01377
S/N 0899-16



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

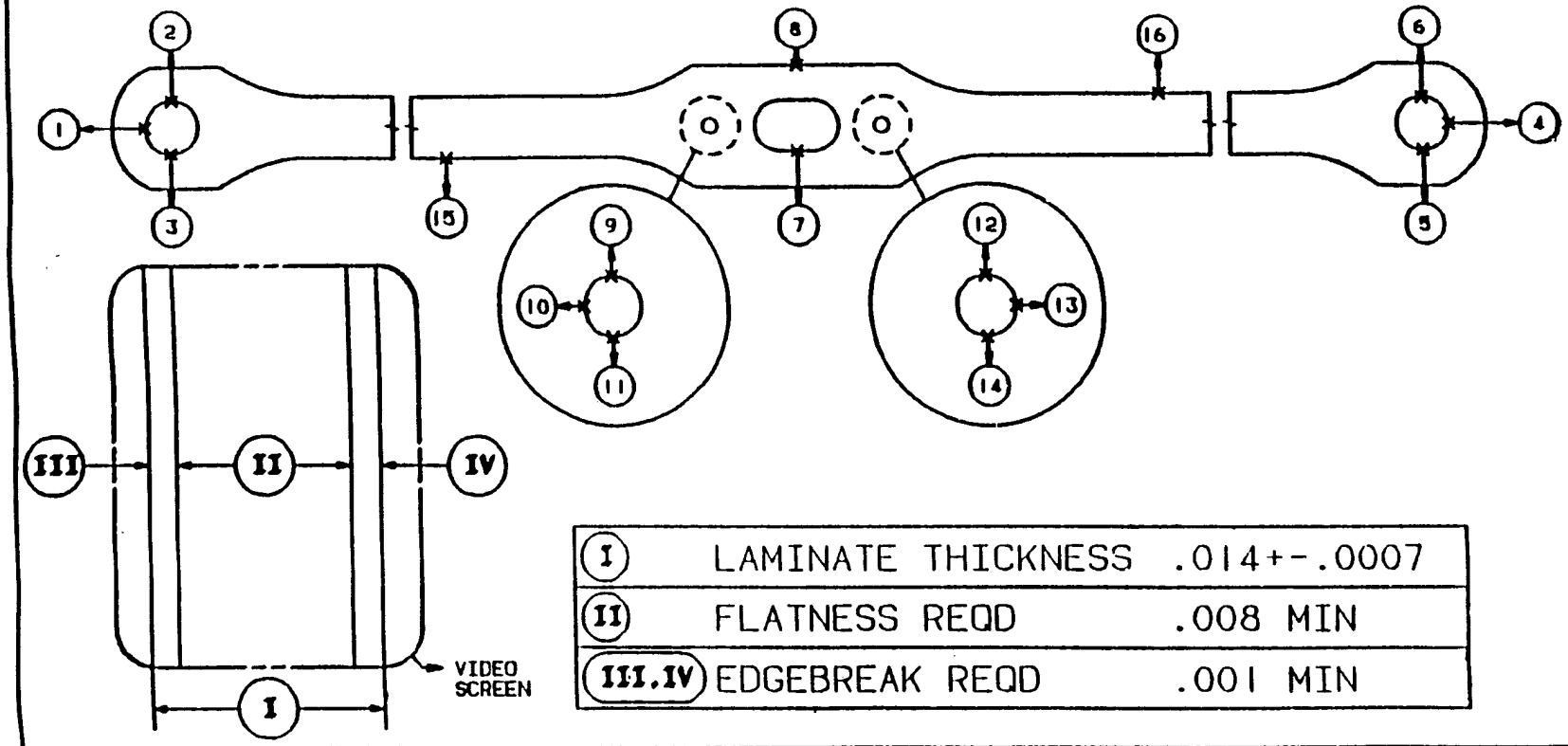
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							0.808	10.787							11.708	11.408
L - TOP							.638	1.714							.168	.516
P - BOTTOM							.800	1.416							.228	.118

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01371**
S/N **0899-17**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

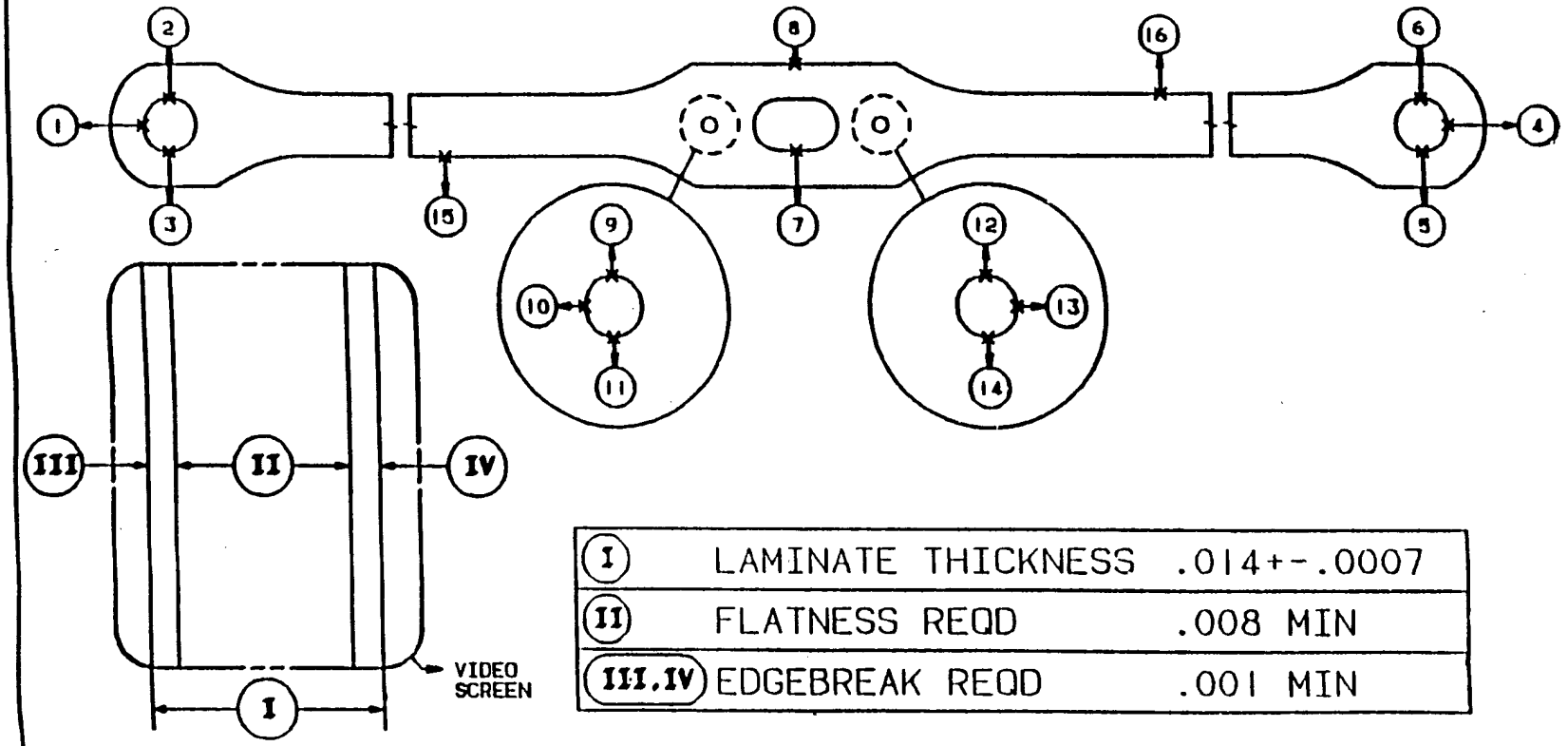
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.234	9.031							1.353	1.058
L - TOP							1.964	2.628							1.405	1.823
P - BOTTOM							1.407	2.250							1.125	1.197

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01374**
S/N **0899-18**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

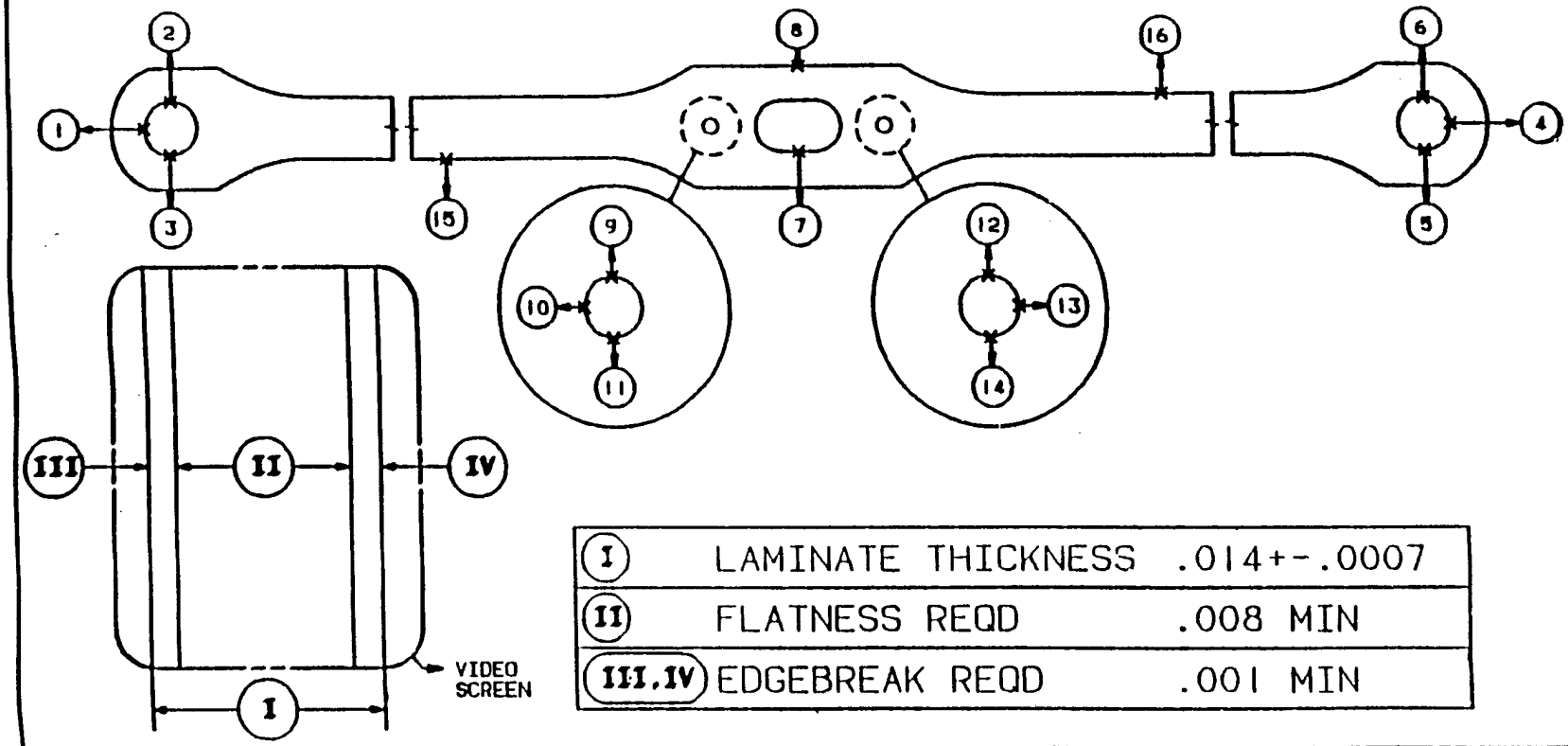
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.375	9.710							10.211	10.528
L - TOP							2.145	2.763							2.083	.954
P - BOTTOM							1.725	1.618							.863	.496

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01376
S/N 0899-19 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

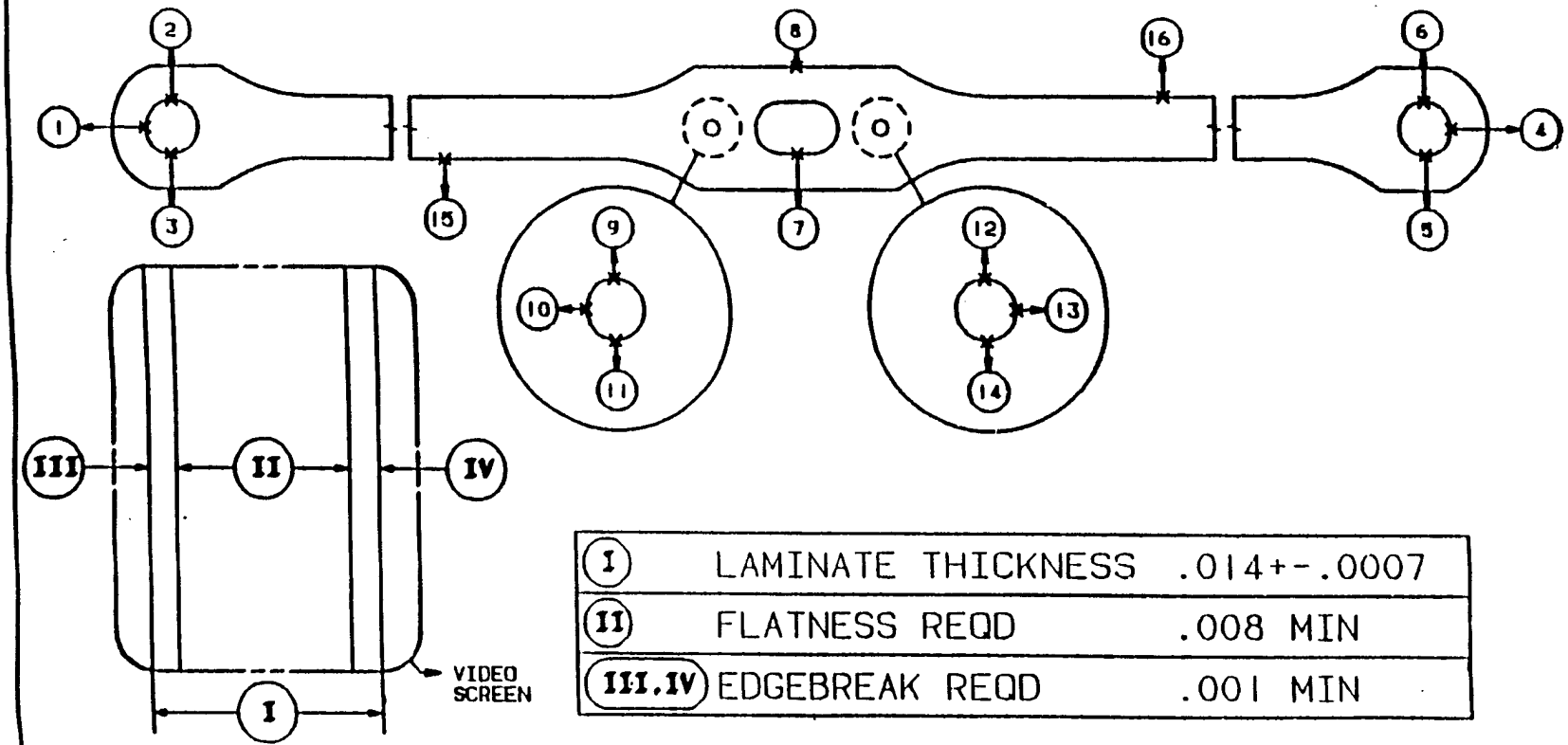
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.486	10.901							0.445	0.269
L - TOP							1.618	1.809							2.083	1.952
P - BOTTOM							1.779	1.745							1.700	2.068

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01385**
S/N **0899-20**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

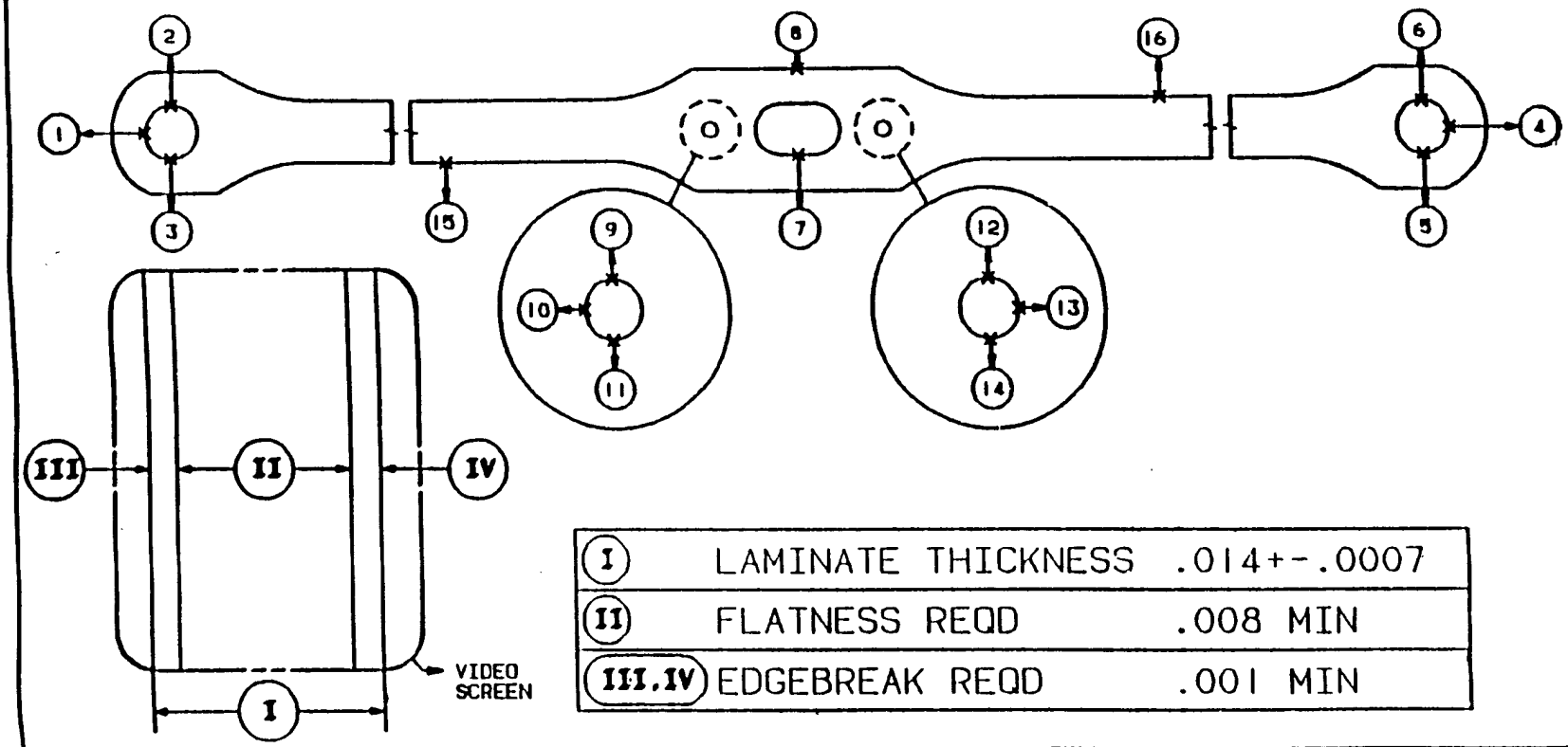
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.406	8.970							10.393	10.087
L - TOP							1.888	3.266							2.453	2.421
P - BOTTOM							1.766	1.896							2.170	1.909

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01385**
S/N **0899-21**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

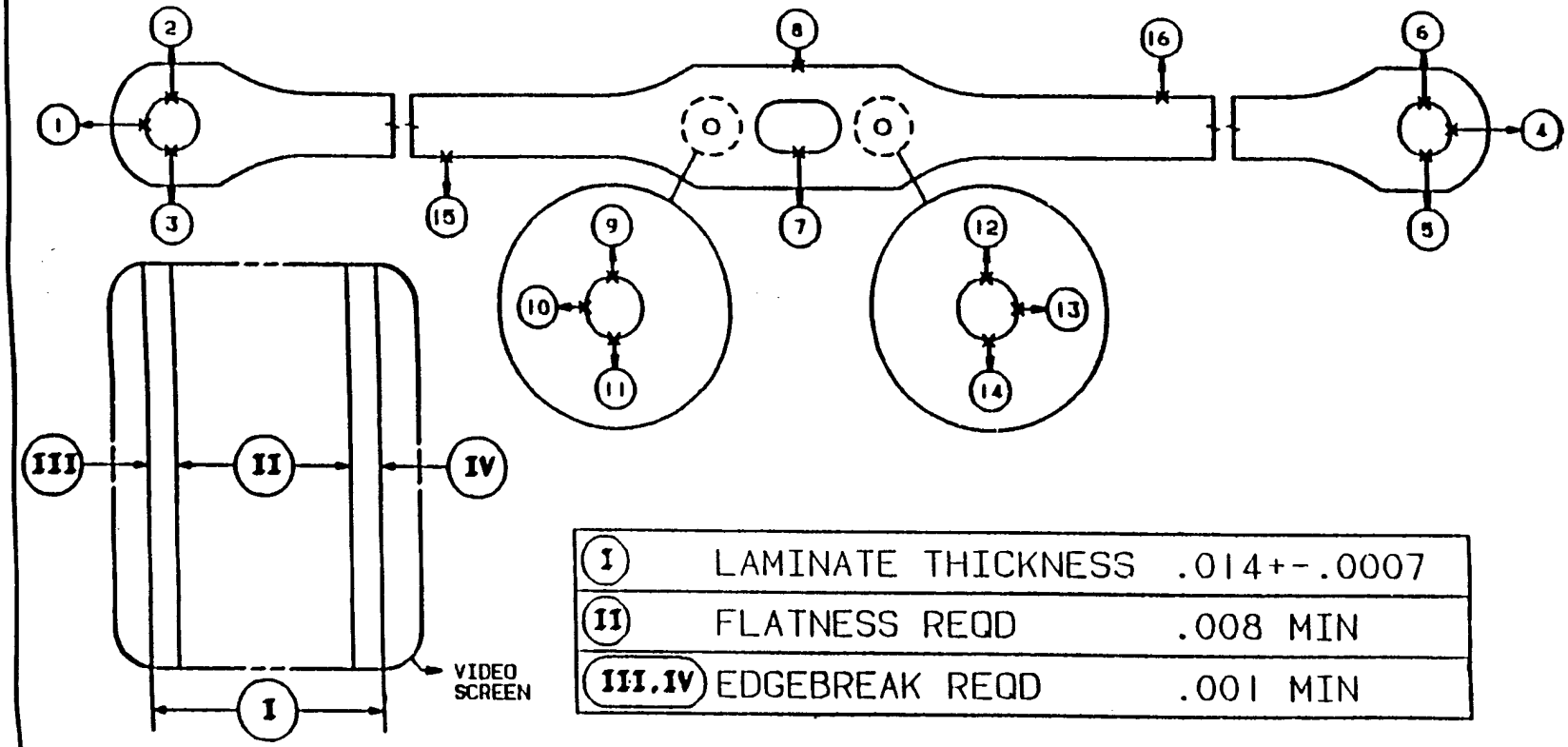
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.744	9.943							9.752	11.312
L - TOP							2.843	2.295							2.173	1.449
P - BOTTOM							1.700	1.682							2.007	1.399

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01365
S/N 0899-22



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.948	9.464							9.705	10.911
L - TOP							2.83	2.869							2.237	2.038
P - BOTTOM							1.902	1.792							2.008	1.242

NOTE NOT TO SCALE

Appendix B:

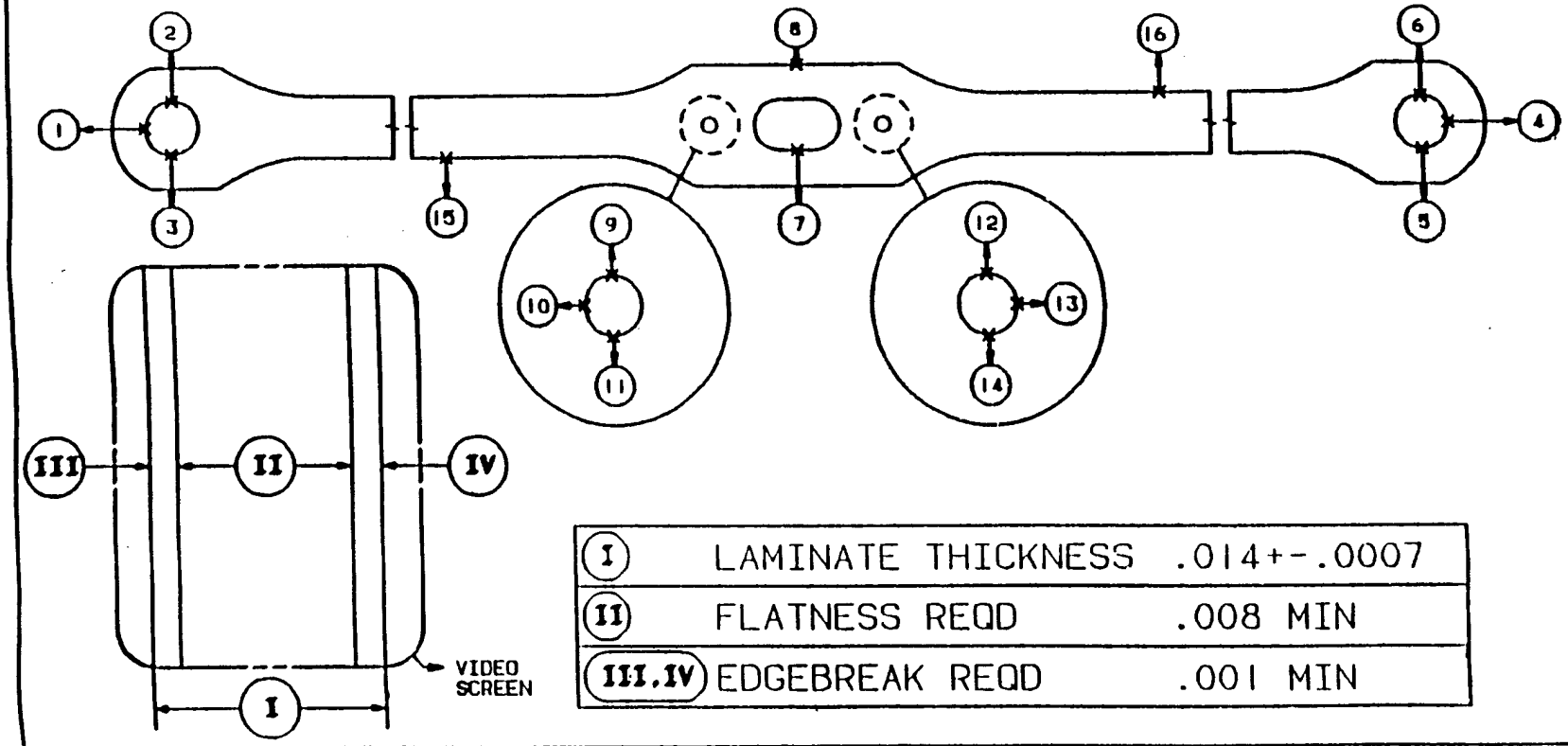
Edge Break Data for Strap Pack 1548

INTENTIONALLY LEFT BLANK.

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01420
S/N 1548-1 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

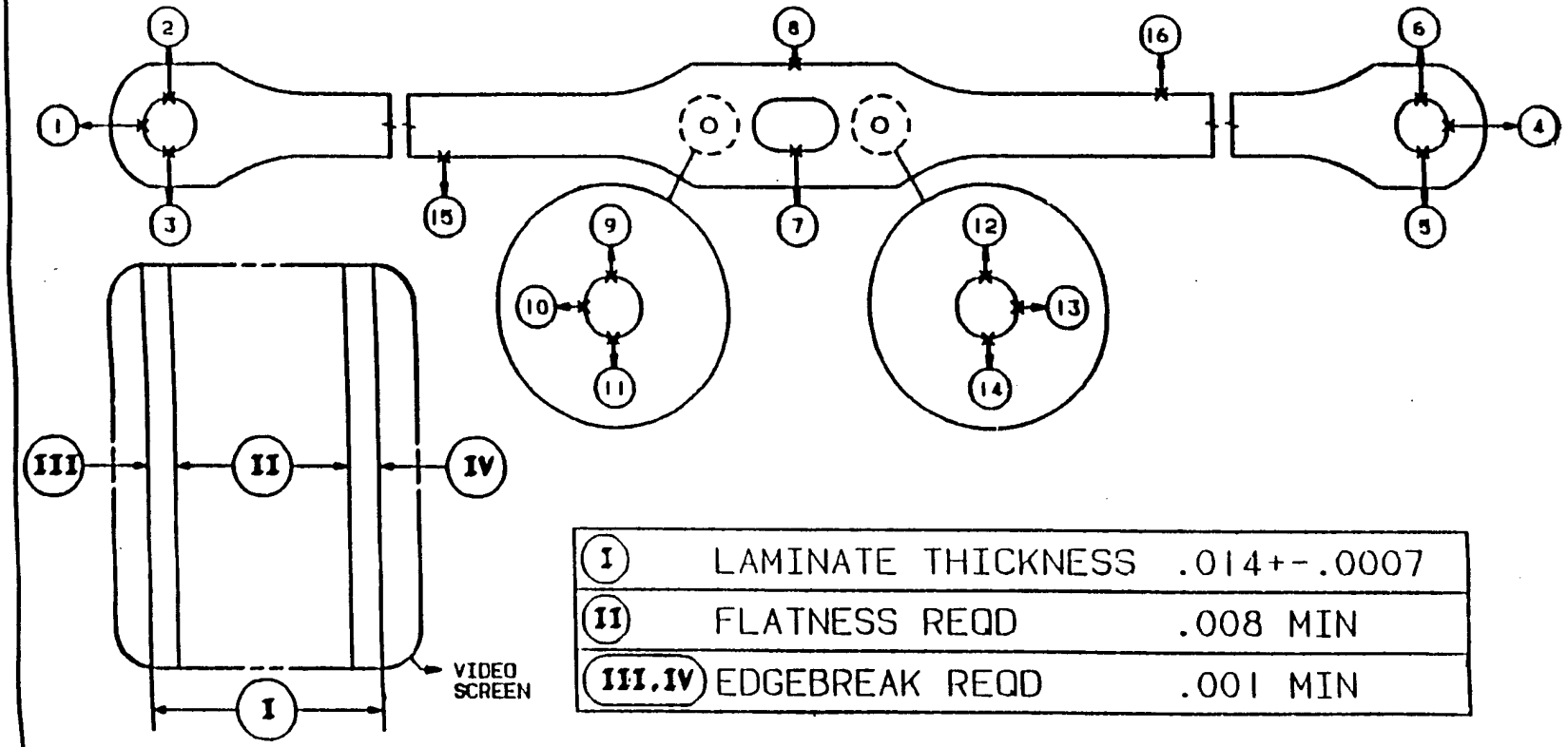
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.846	10.242							12.097	11.841
L - TOP							1.526	1.869							1.097	1.024
P - BOTTOM							1.537	2.412							1.253	1.526

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01415
S/N 1548-2 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

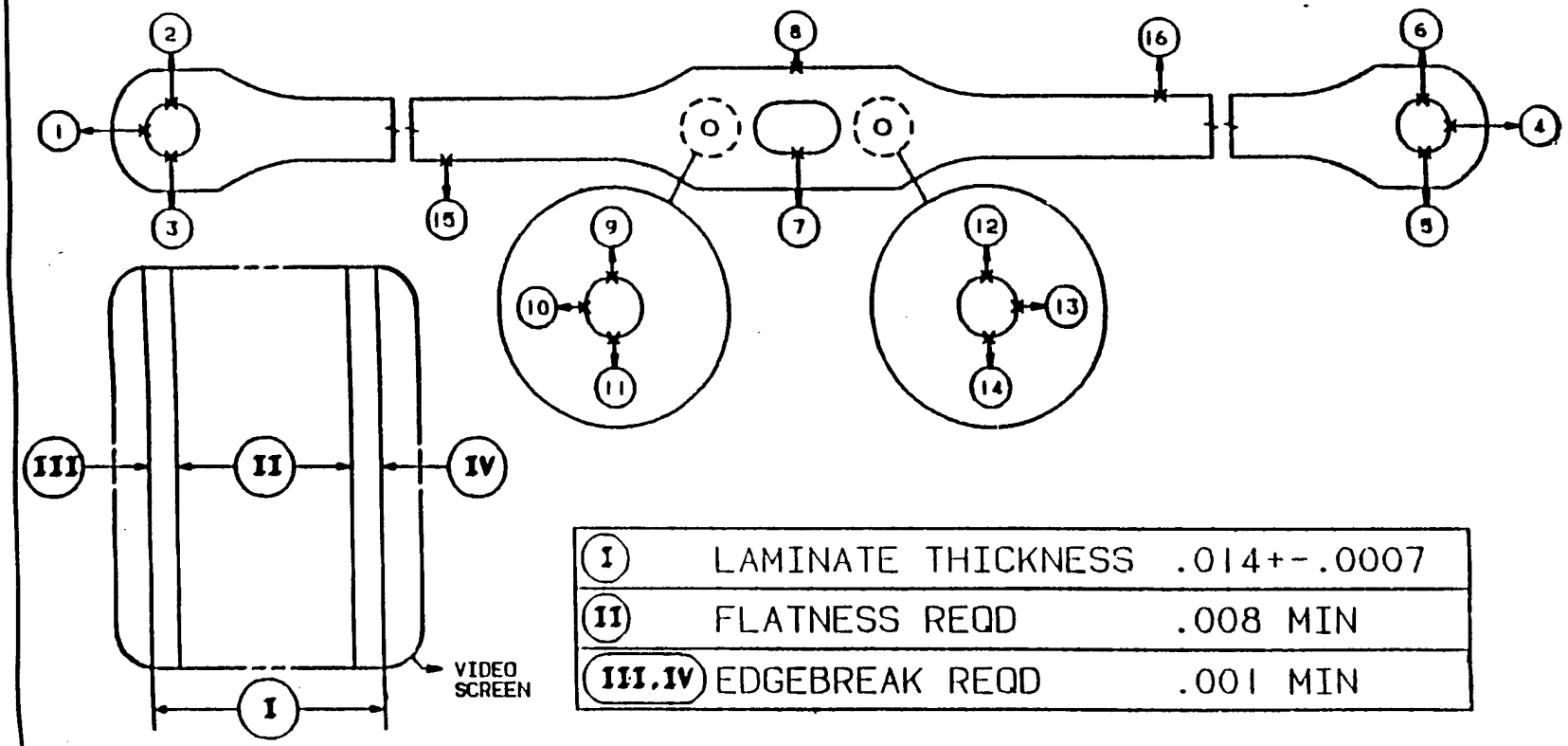
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.455	10.444							11.324	12.349
L - TOP							2.106	2.038							1.864	1.095
P - BOTTOM							1.995	1.754							1.308	1.024

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01414**
S/N **1548-3**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

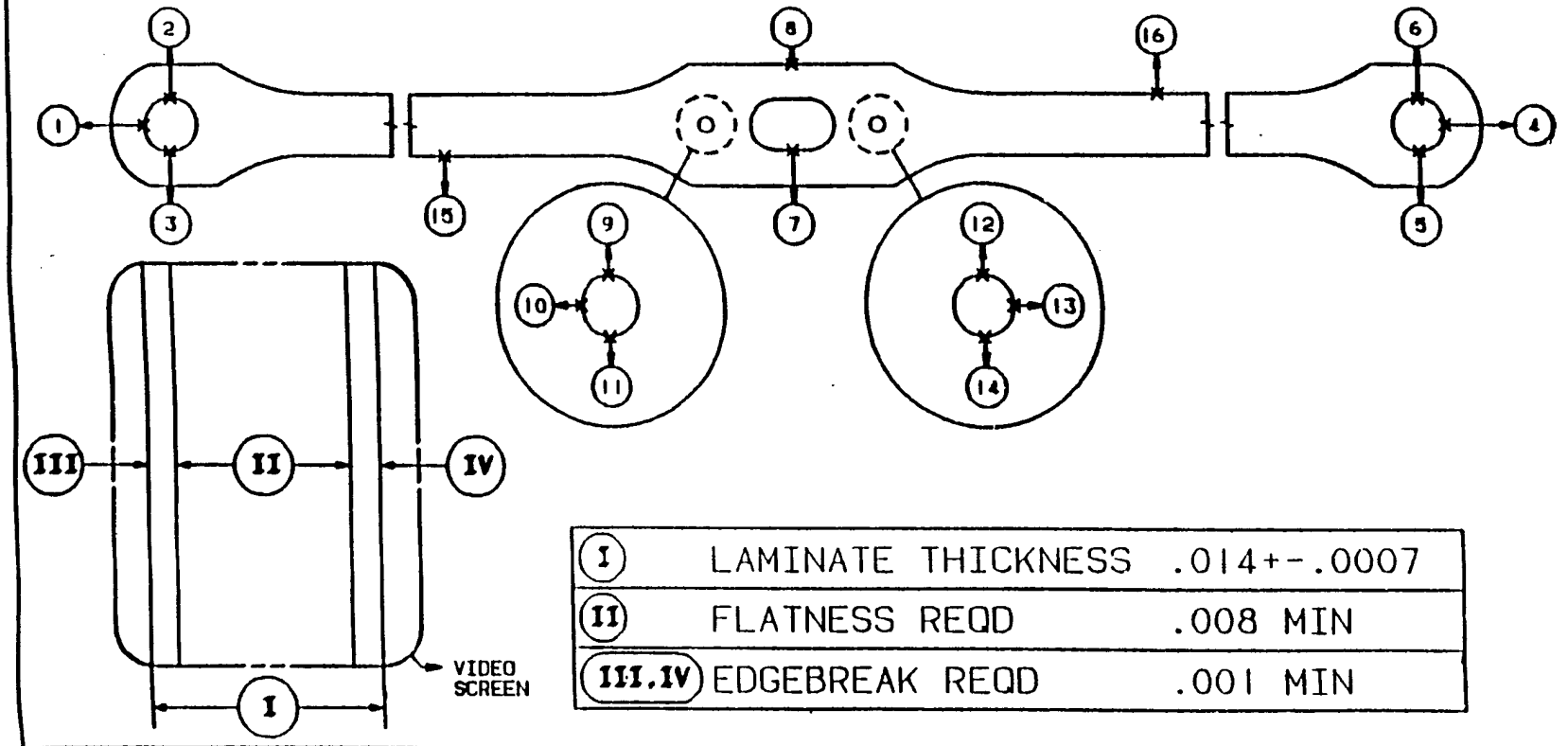
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.893	9.553							11.917	11.781
L - TOP							1.864	2.339							1.283	1.779
P - BOTTOM							1.027	2.629							1.283	1.097

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01417
S/N 1548-4



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

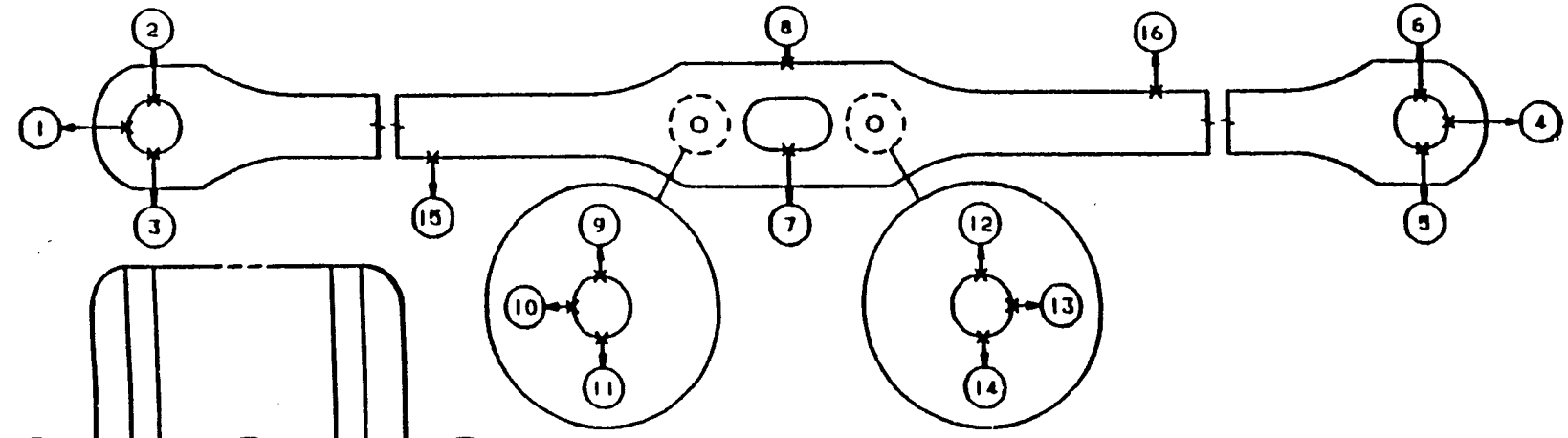
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.726	10.407							1.743	1.658
L - TOP							1.986	2.257							1.416	1.419
P - BOTTOM							1.757	1.794							1.471	1.308

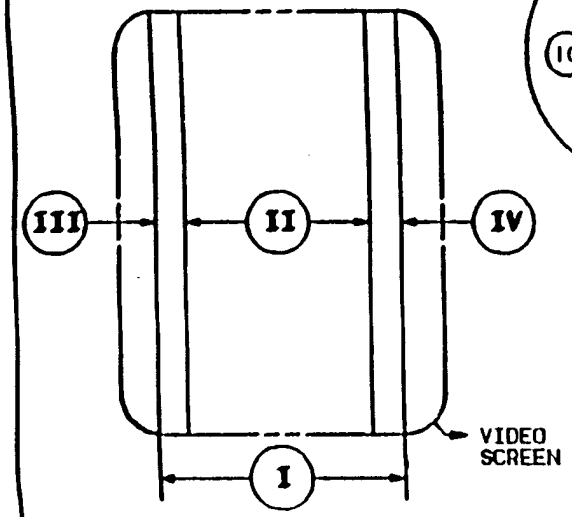
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01416**
S/N **1548-5**





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

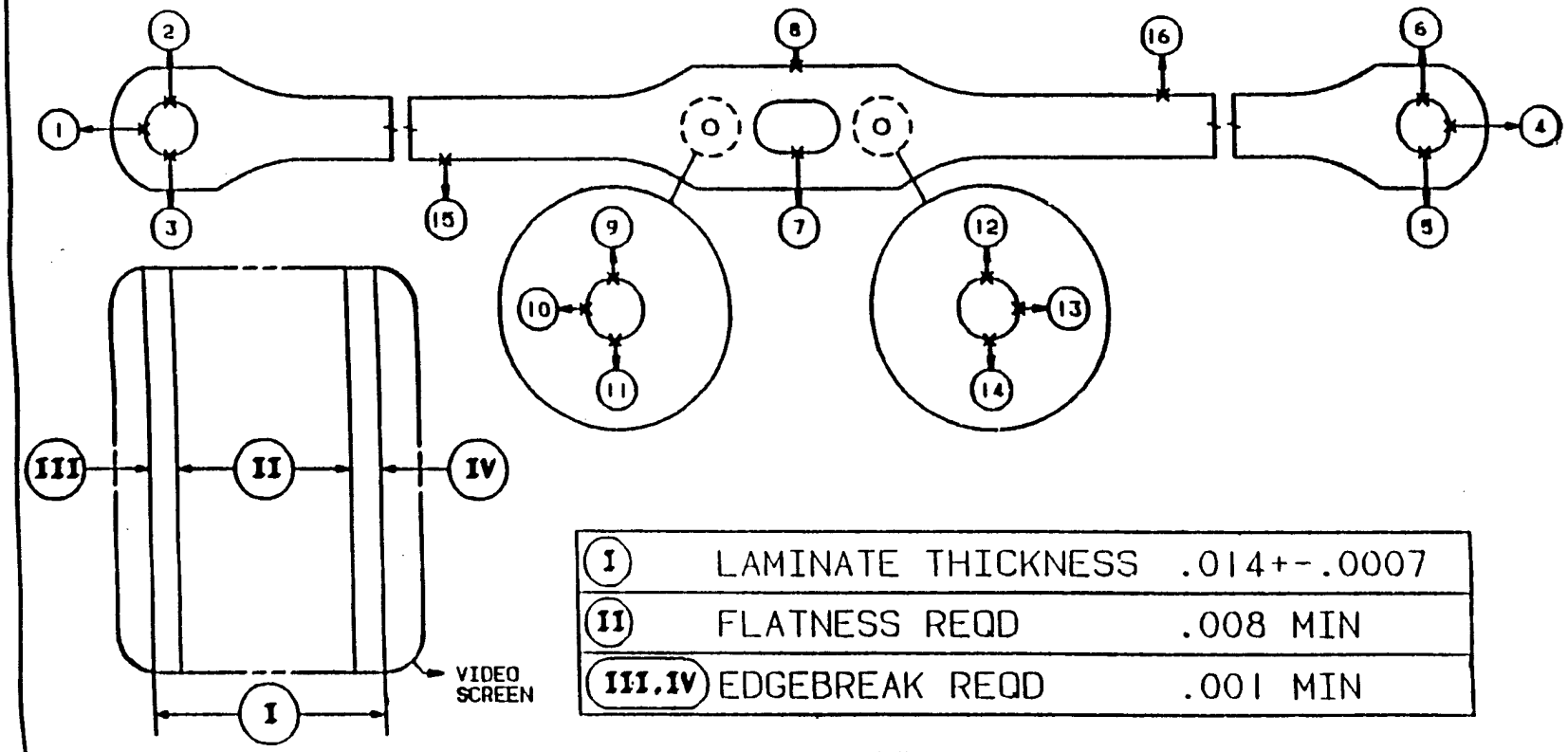
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.104	11.115							11.237	12.099
L - TOP							1.818	1.986							2.278	1.253
P - BOTTOM							1.405	1.496							1.962	1.145

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01415**
S/N **1548-6**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

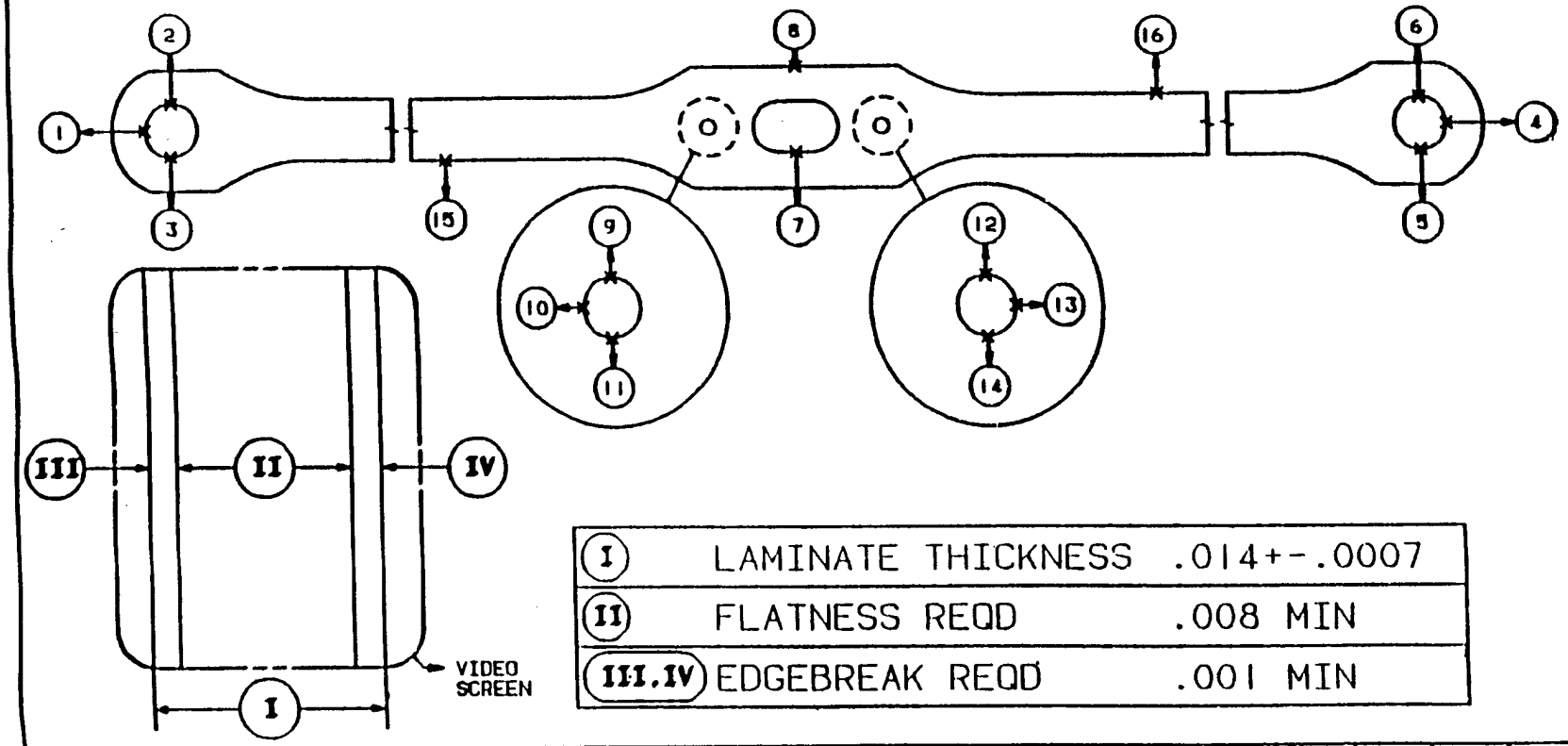
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.636	11.484							1.196	9.387
L - TOP							2.198	1.814							2.075	2.198
P - BOTTOM							2.656	1.550							1.405	2.355

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01417
S/N 1548-7



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

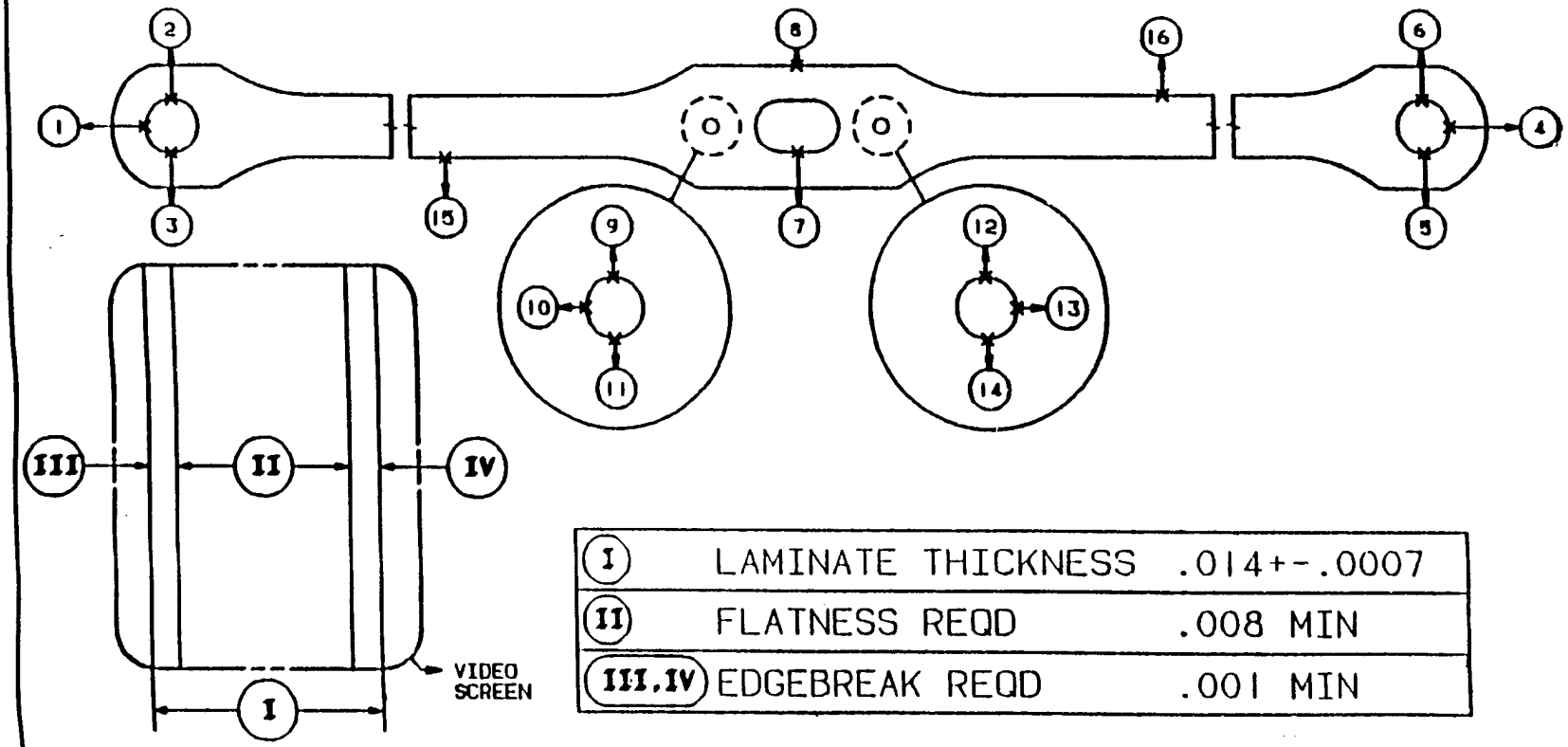
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.187	10.611							10.125	9.901
L - TOP							2.127	2.656							2.092	2.237
P - BOTTOM							1.634	1.561							2.023	2.145

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01416**
S/N **1548-8**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

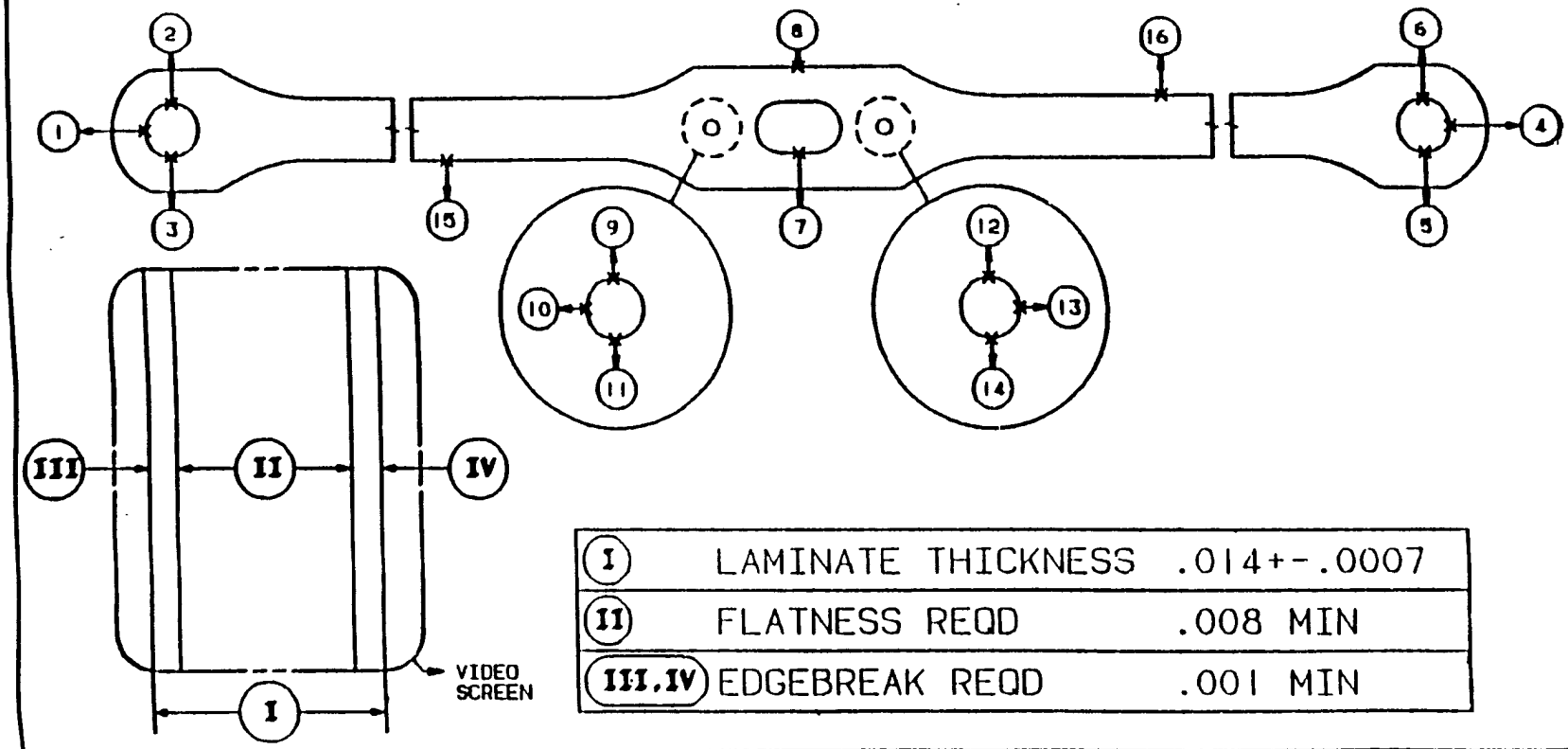
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.406	10.529							10.215	10.528
L - TOP							1.706	1.987							2.654	2.198
P - BOTTOM							1.845	2.320							1.828	1.618

NOTE-NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01431
S/N 1548-9



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

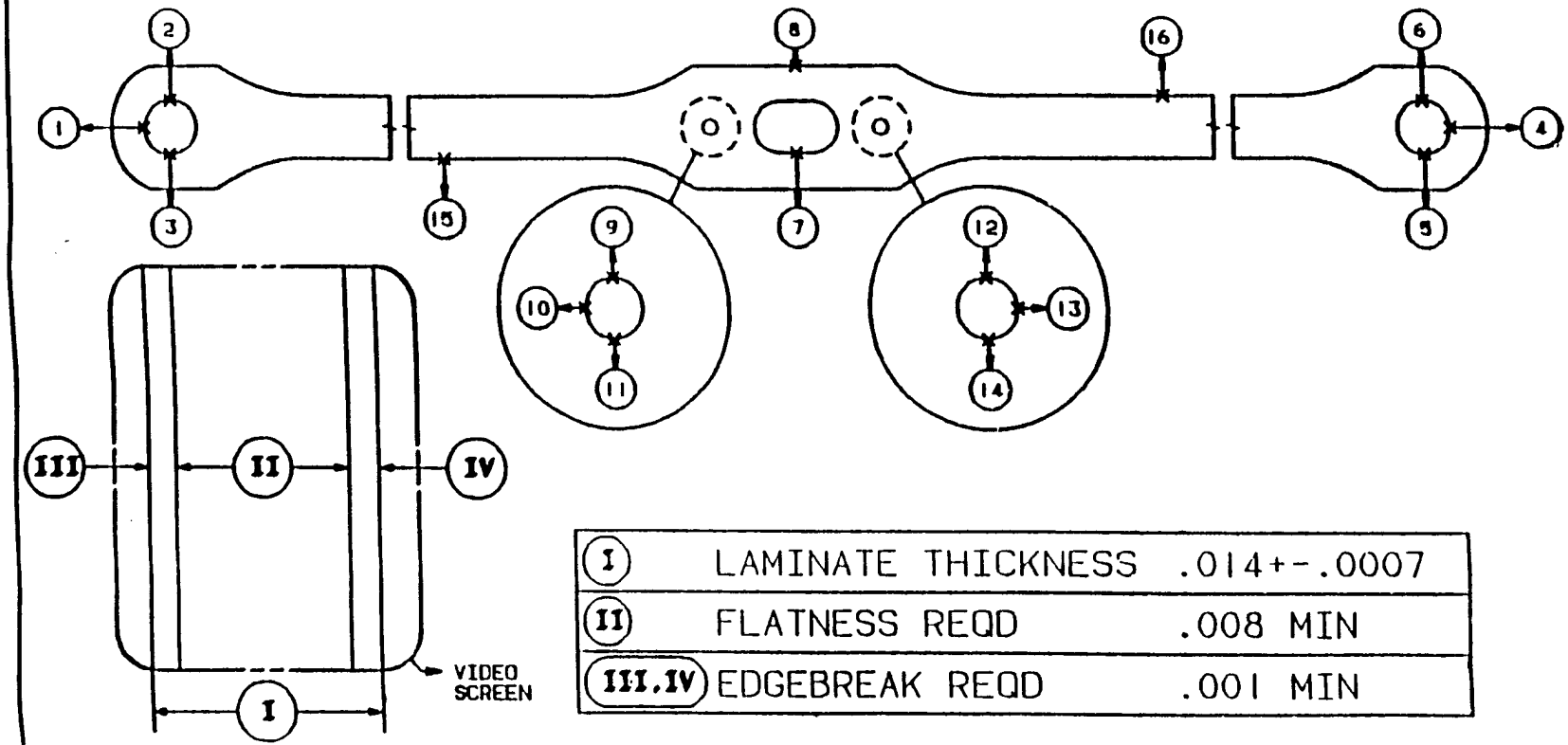
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.862	9.337							10.950	11.147
L - TOP							2.569	2.443							1.828	1.634
P - BOTTOM							1.899	2.390							1.687	1.405

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01425
S/N 1548-10



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

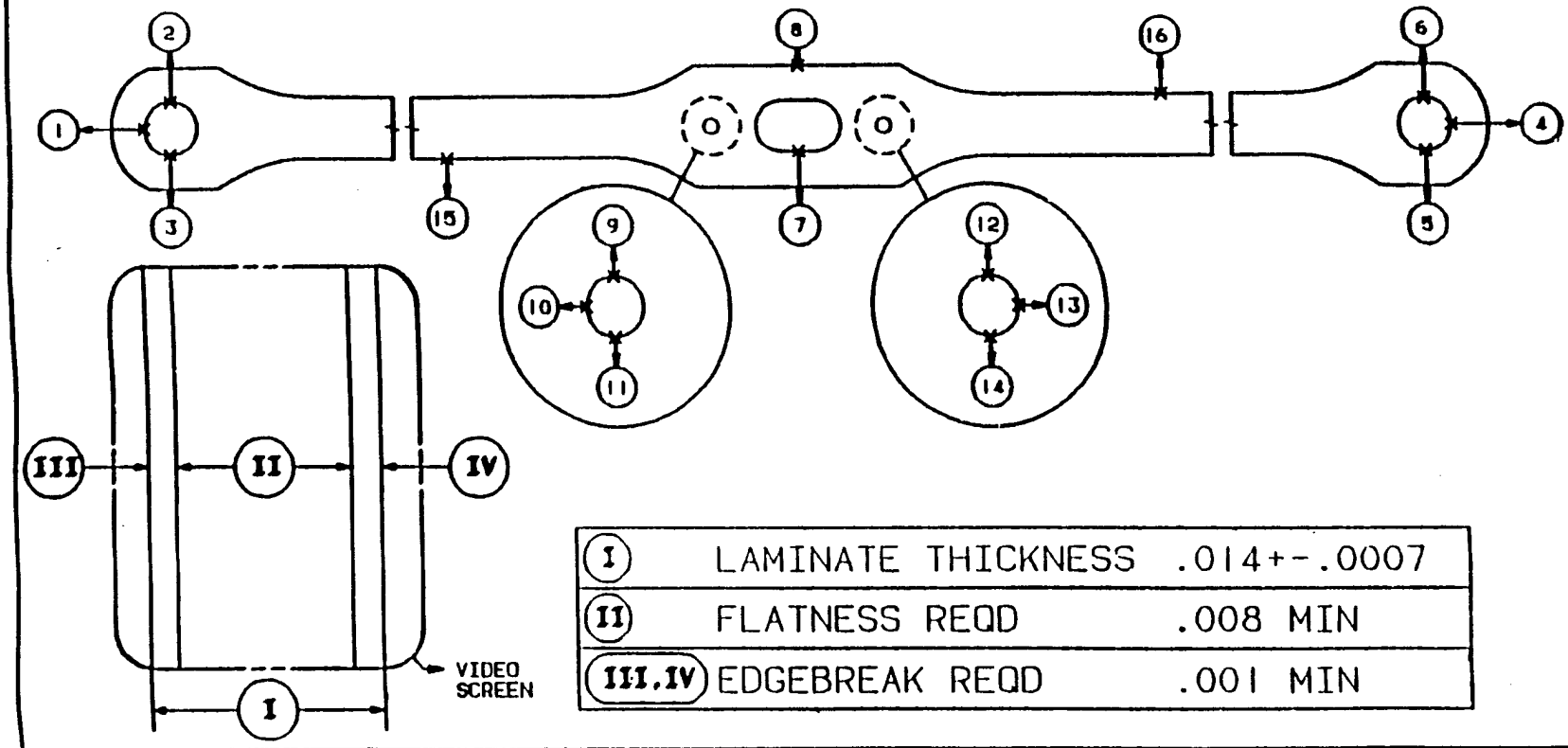
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.856	10.105							10.414	11.234
L - TOP							2.621	2.355							2.240	1.754
P - BOTTOM							1.795	1.704							2.341	1.548

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01415
S/N 1548-11



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

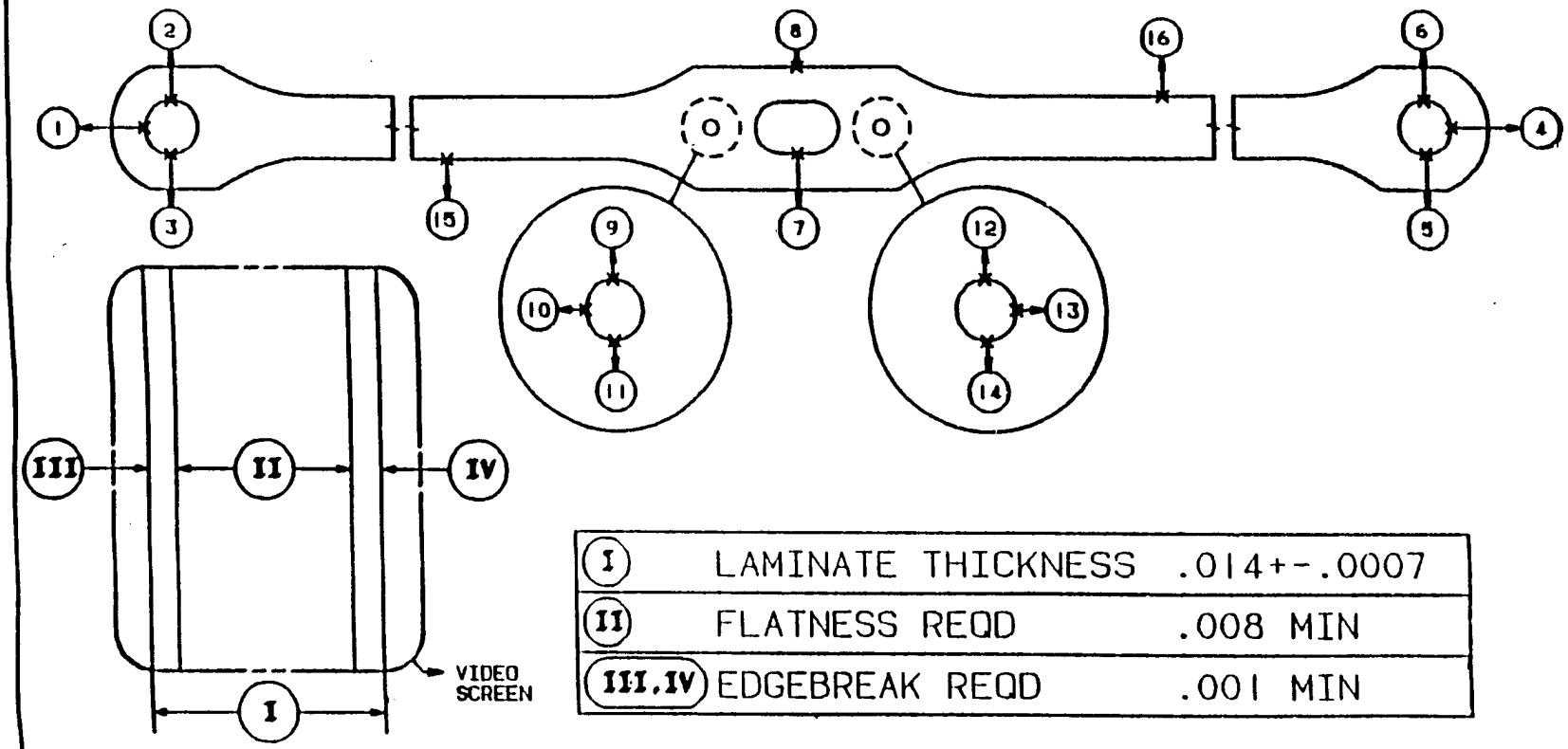
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.083	10.898							11.467	11.001
L - TOP							1.692	1.775							1.642	1.863
P - BOTTOM							1.446	1.775							1.424	1.548

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01415**
S/N **1548-12**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

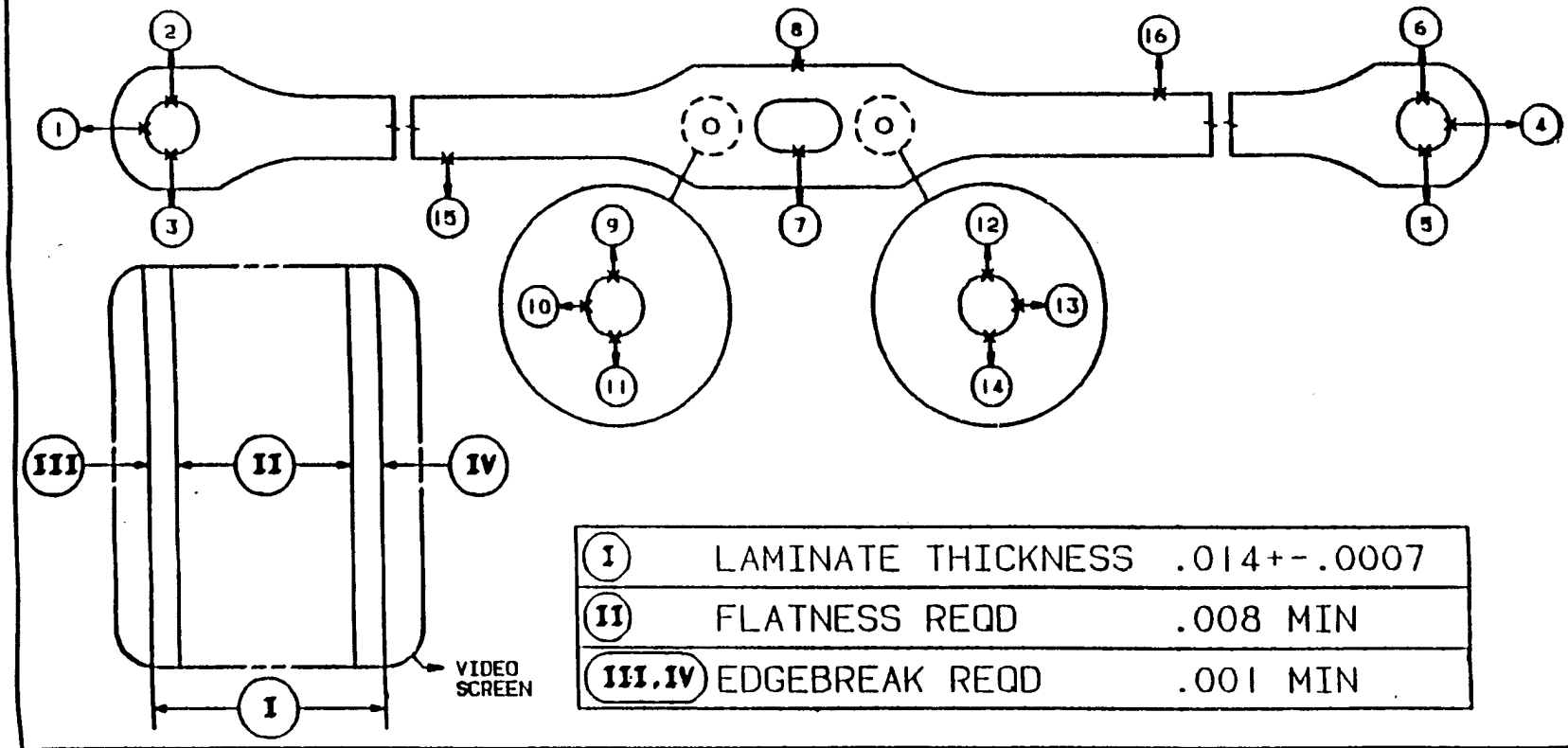
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.670	11.391							10.439	11.024
L - TOP							2.218	1.951							2.426	1.880
P - BOTTOM							2.167	1.548							1.372	1.353

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01422
S/N 1548-13



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

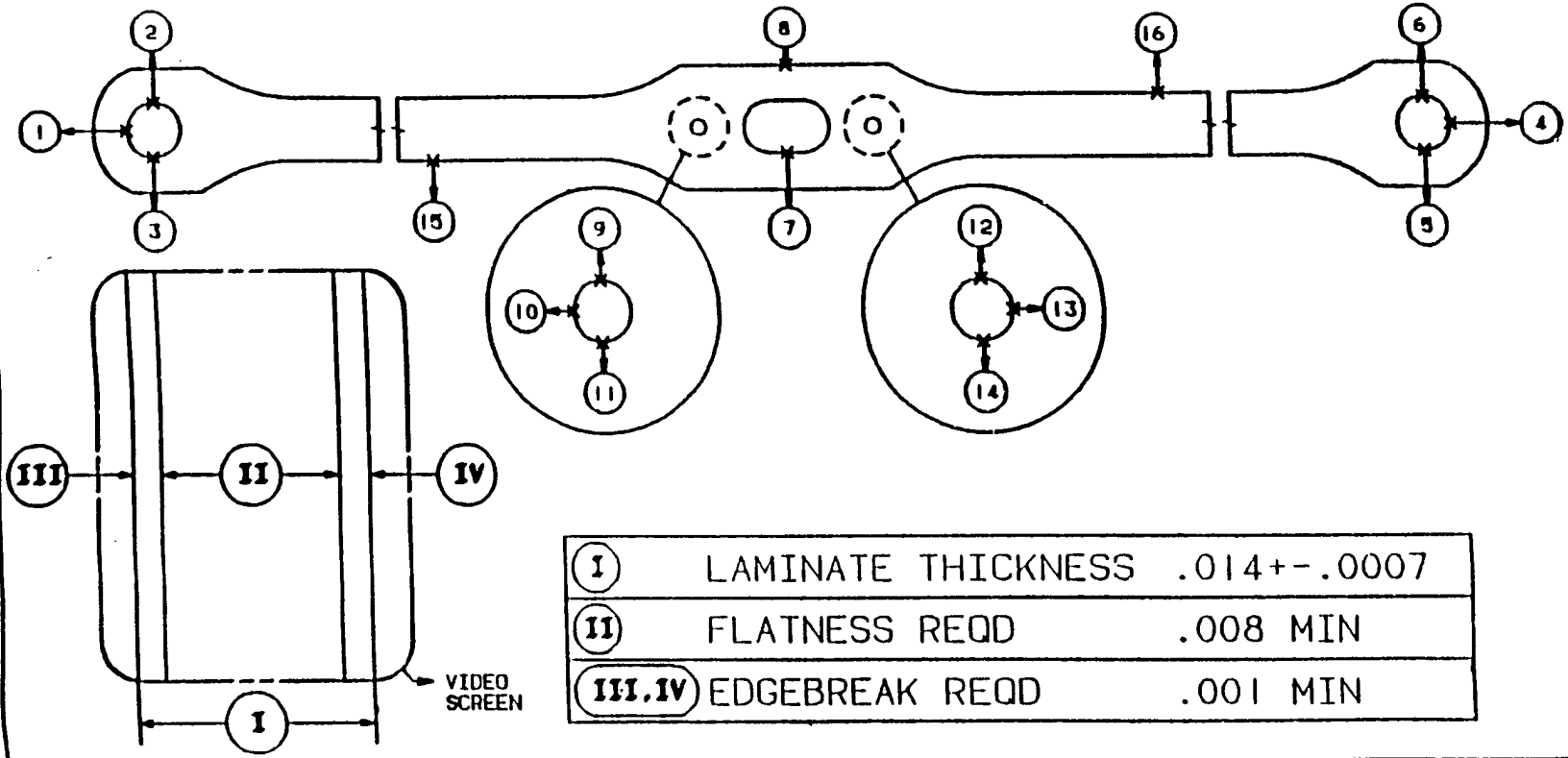
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.099	10.320							10.888	11.024
L - TOP							1.683	1.971							2.138	1.441
P - BOTTOM							1.817	2.065							1.467	1.890

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01411
S/N 1548-14



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.873	10.042							11.159	11.719
L - TOP							2.905	2.262							1.665	1.572
P - BOTTOM							1.964	1.764							1.864	1.227

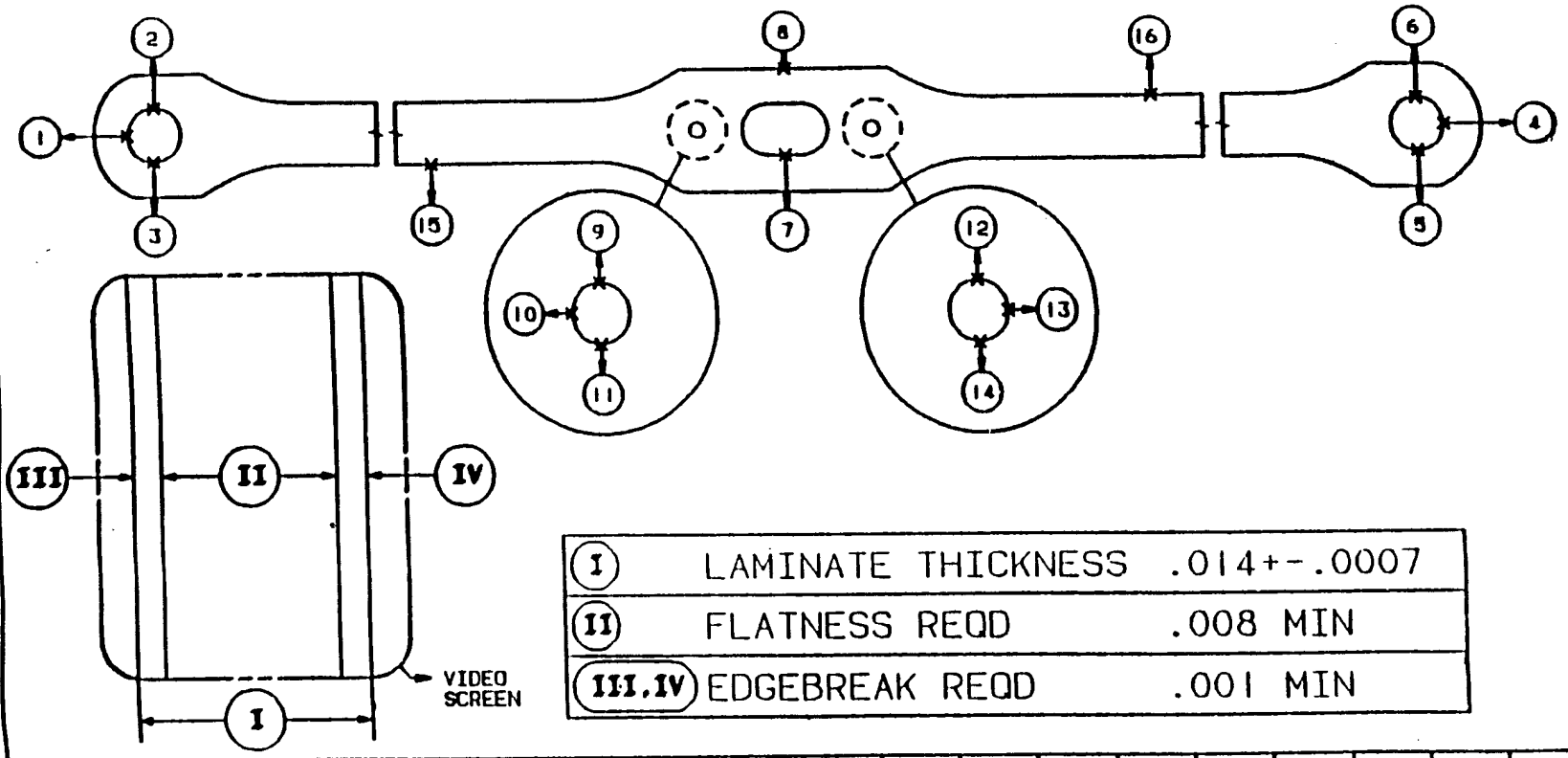
NOTE NOT TO SCALE

09

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01411**
S/N **1548-15**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

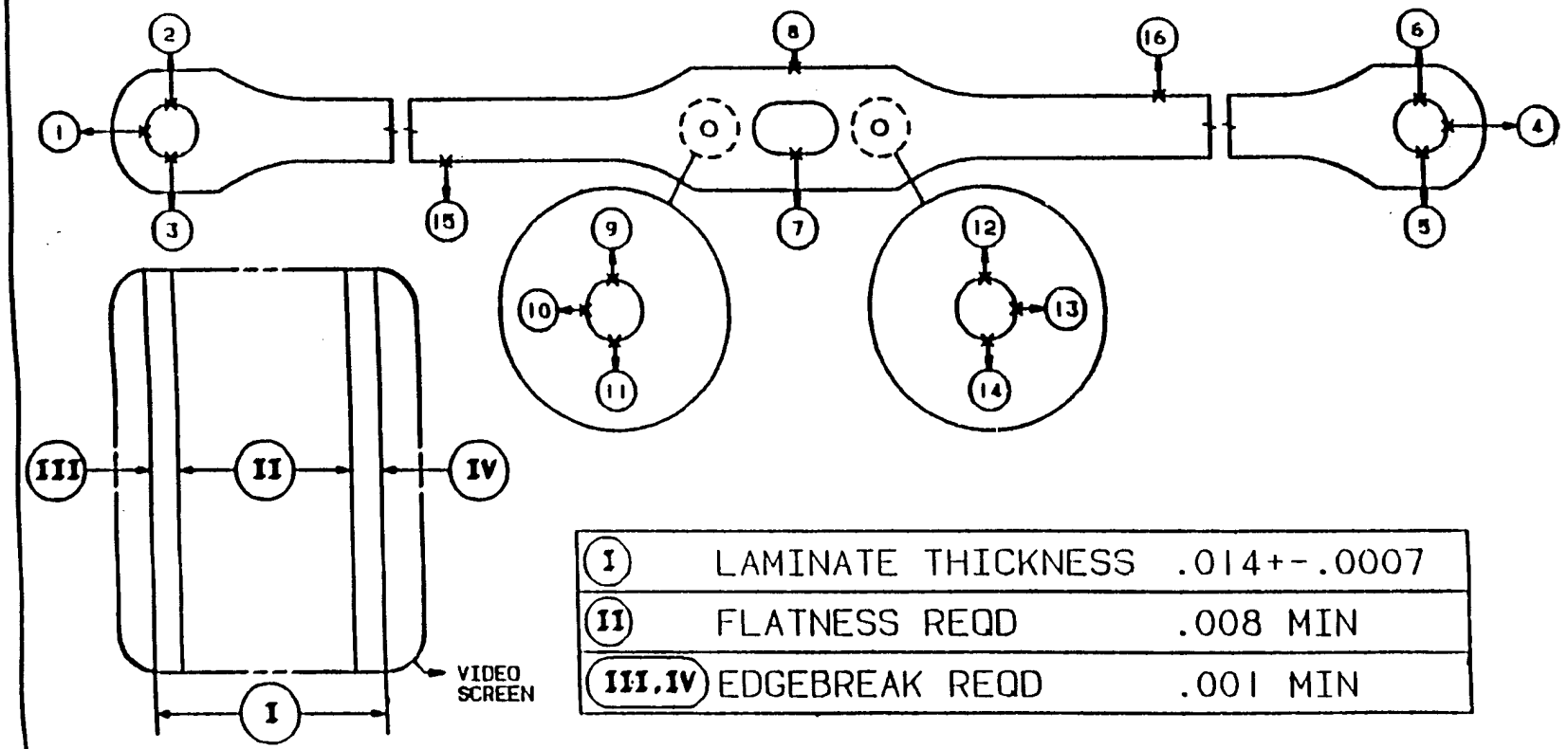
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							11.231	9.594							10.370	11.435
L - TOP							2.003	2.659							2.594	1.917
P - BOTTOM							1.301	2.635							1.775	1.424

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01421
S/N 1548-16 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

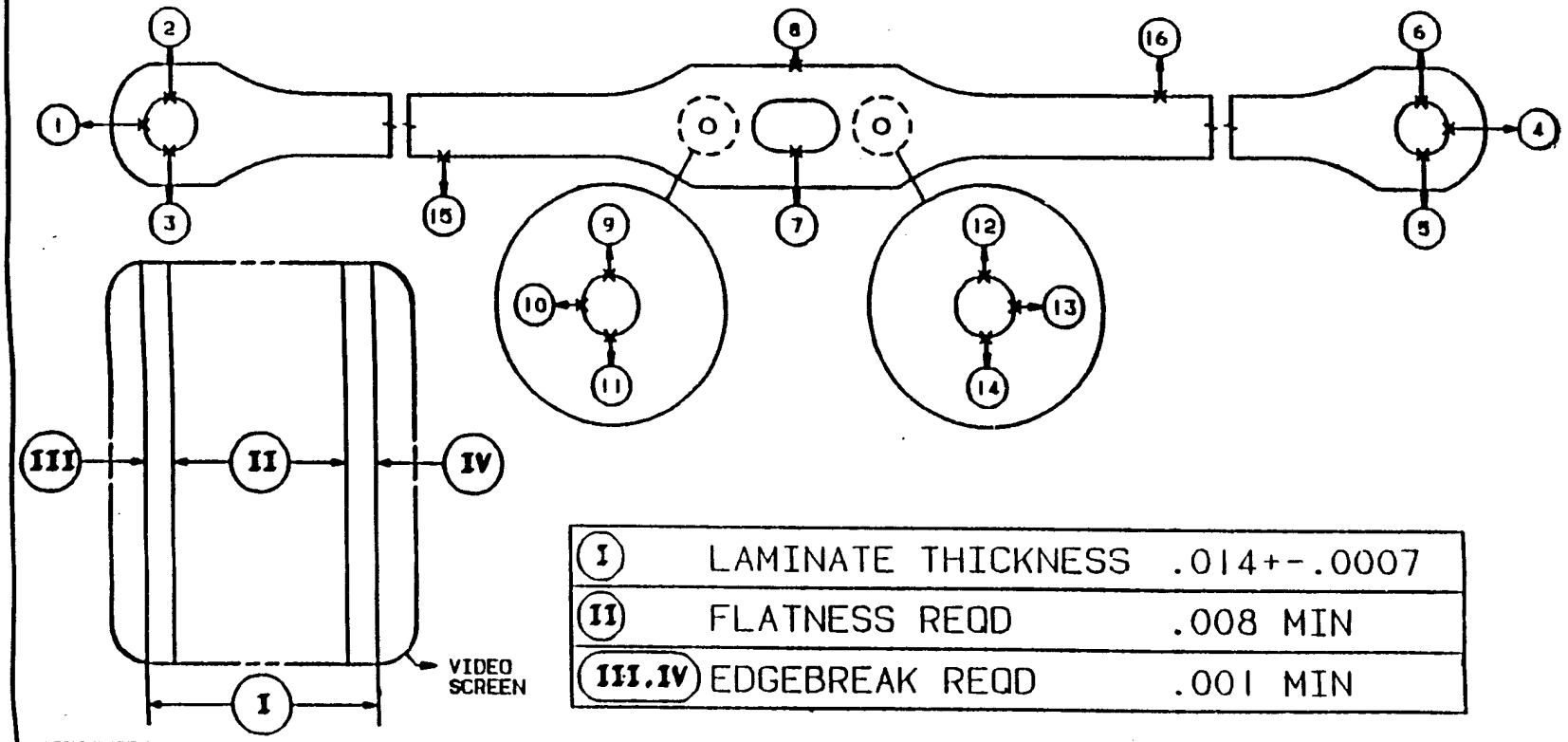
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.063	9.122							10.504	10.561
L - TOP							4.001	3.444							2.112	2.444
P - BOTTOM							1.449	2.000							1.723	1.446

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01416
S/N 1548-17



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

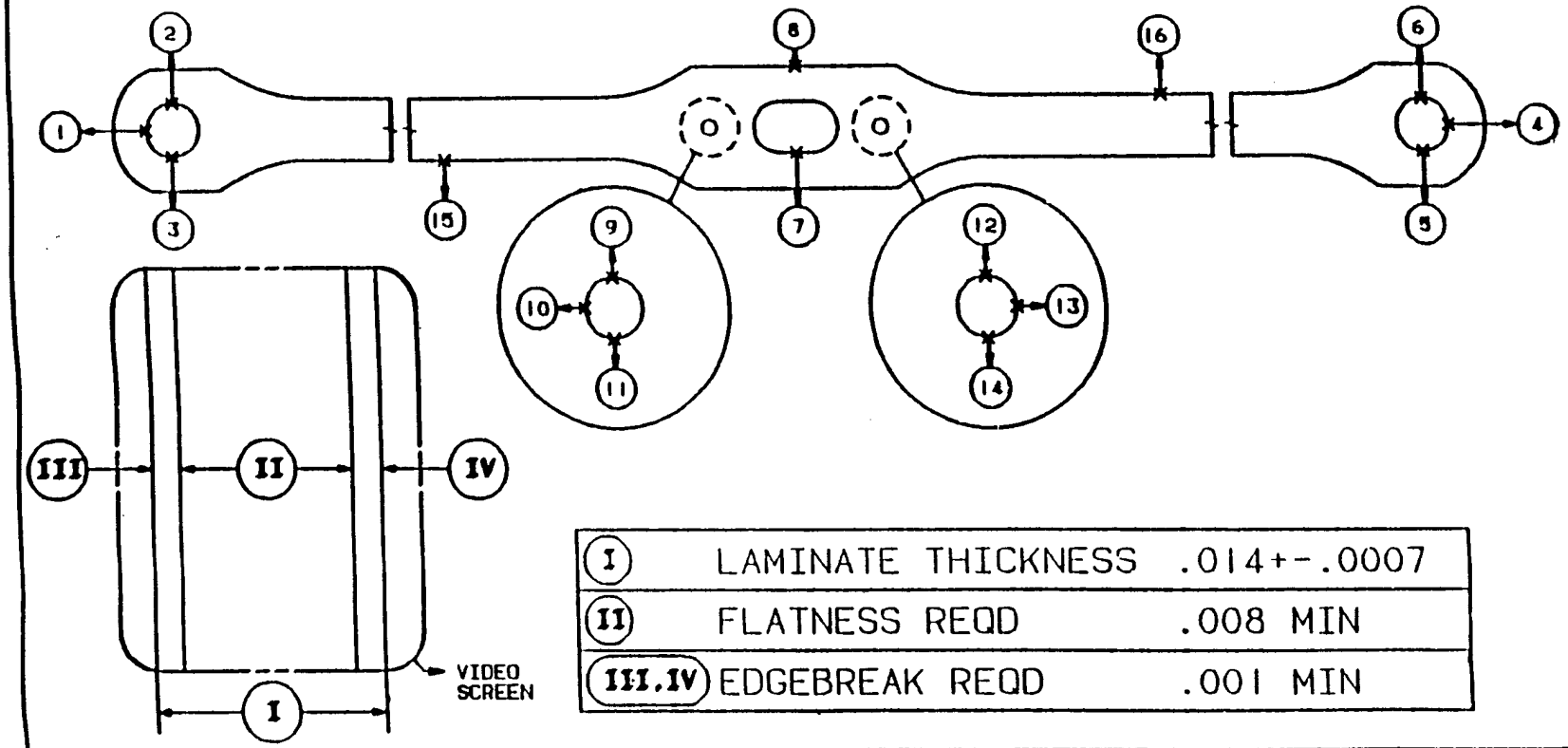
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.889	9.550							11.364	11.451
L - TOP							1.823	2.198							1.795	1.405
P - BOTTOM							1.671	2.766							1.353	1.515

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01415**
S/N **1548-18**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

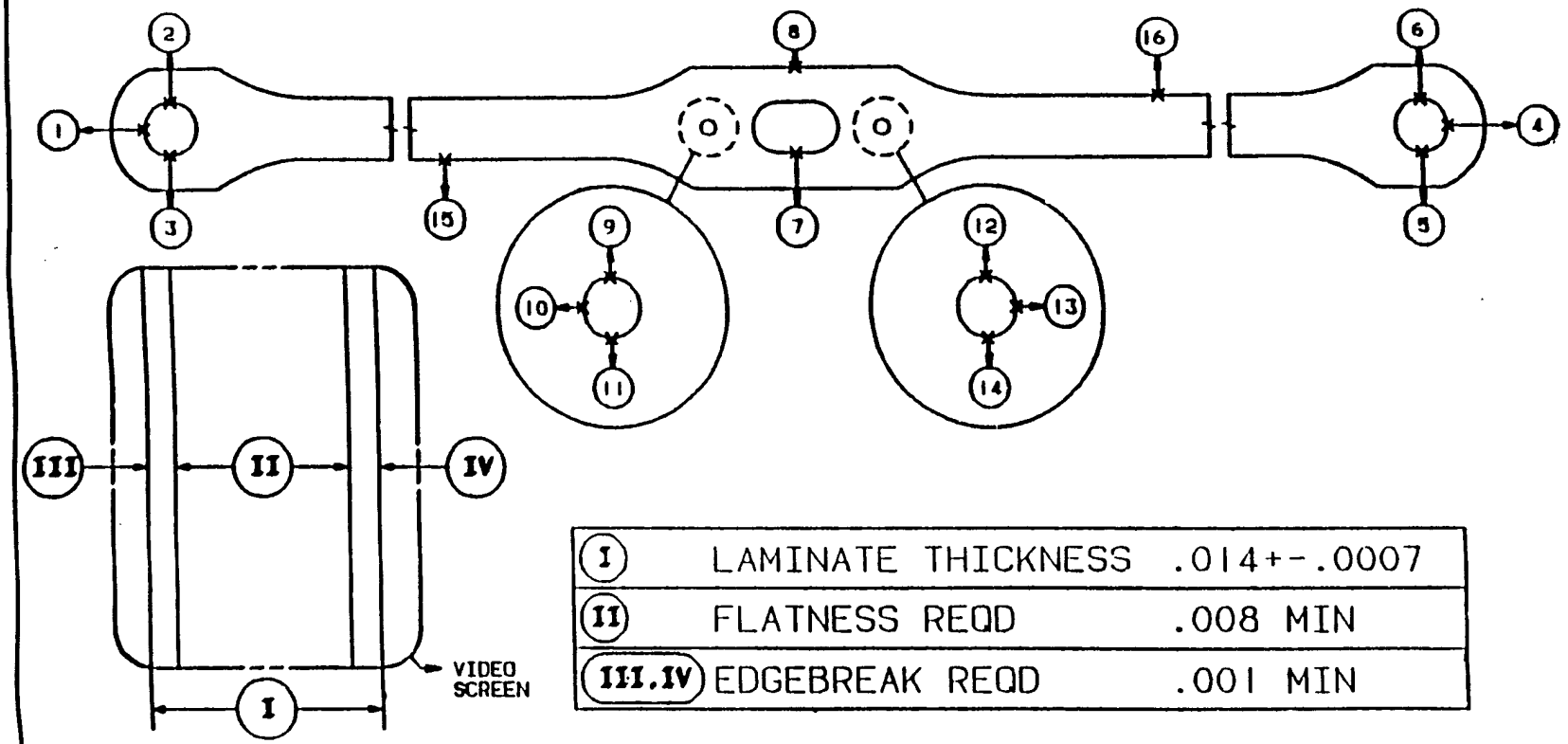
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.882	9.918							11.350	10.786
L - TOP							2.366	2.023							2.212	1.971
P - BOTTOM							1.516	2.415							1.020	1.642

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01412
S/N 1548-19



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

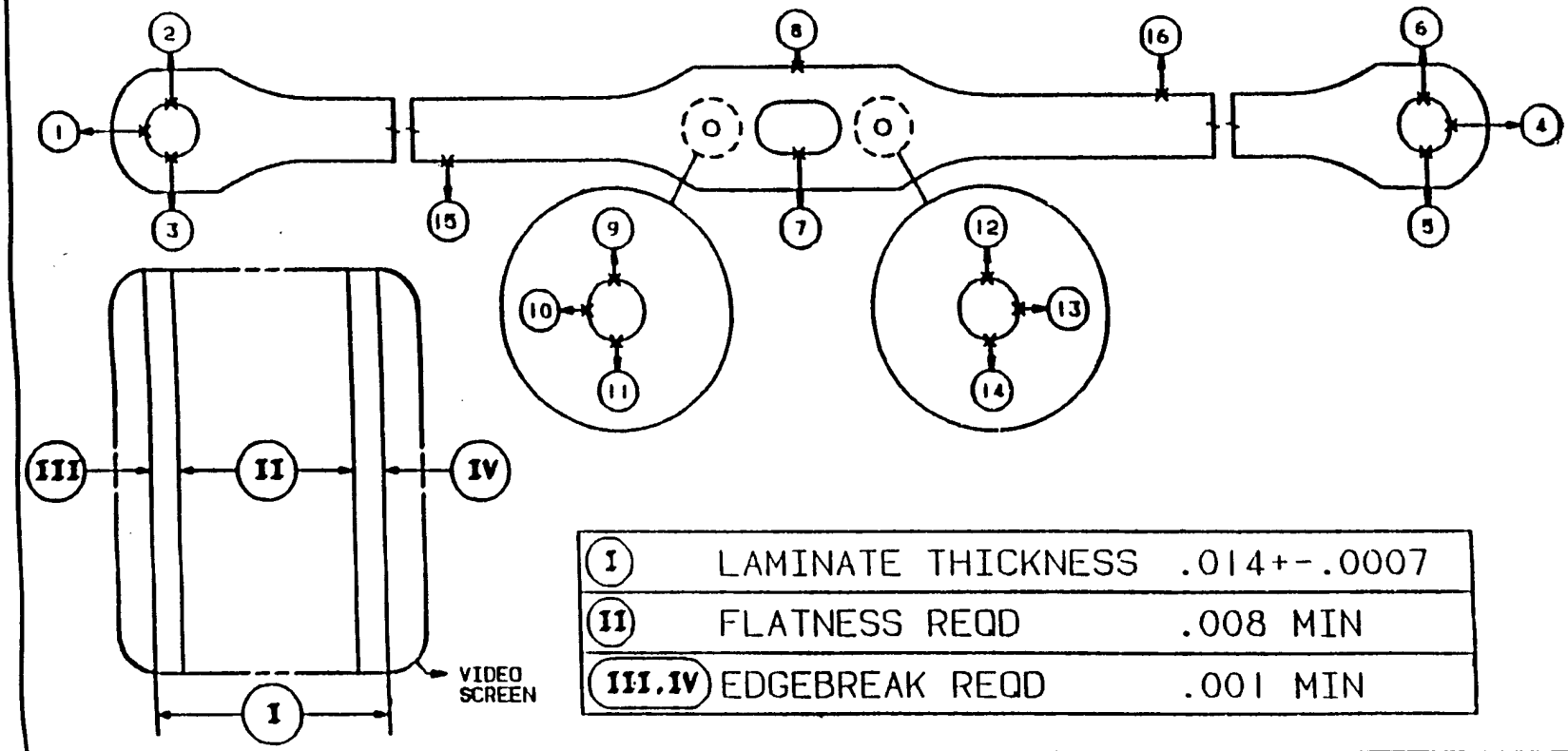
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.298	8.621							10.302	11.206
L - TOP							2.695	3.965							1.645	1.550
P - BOTTOM							1.604	2.637							2.492	1.482

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01415**
S/N **1548-20**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

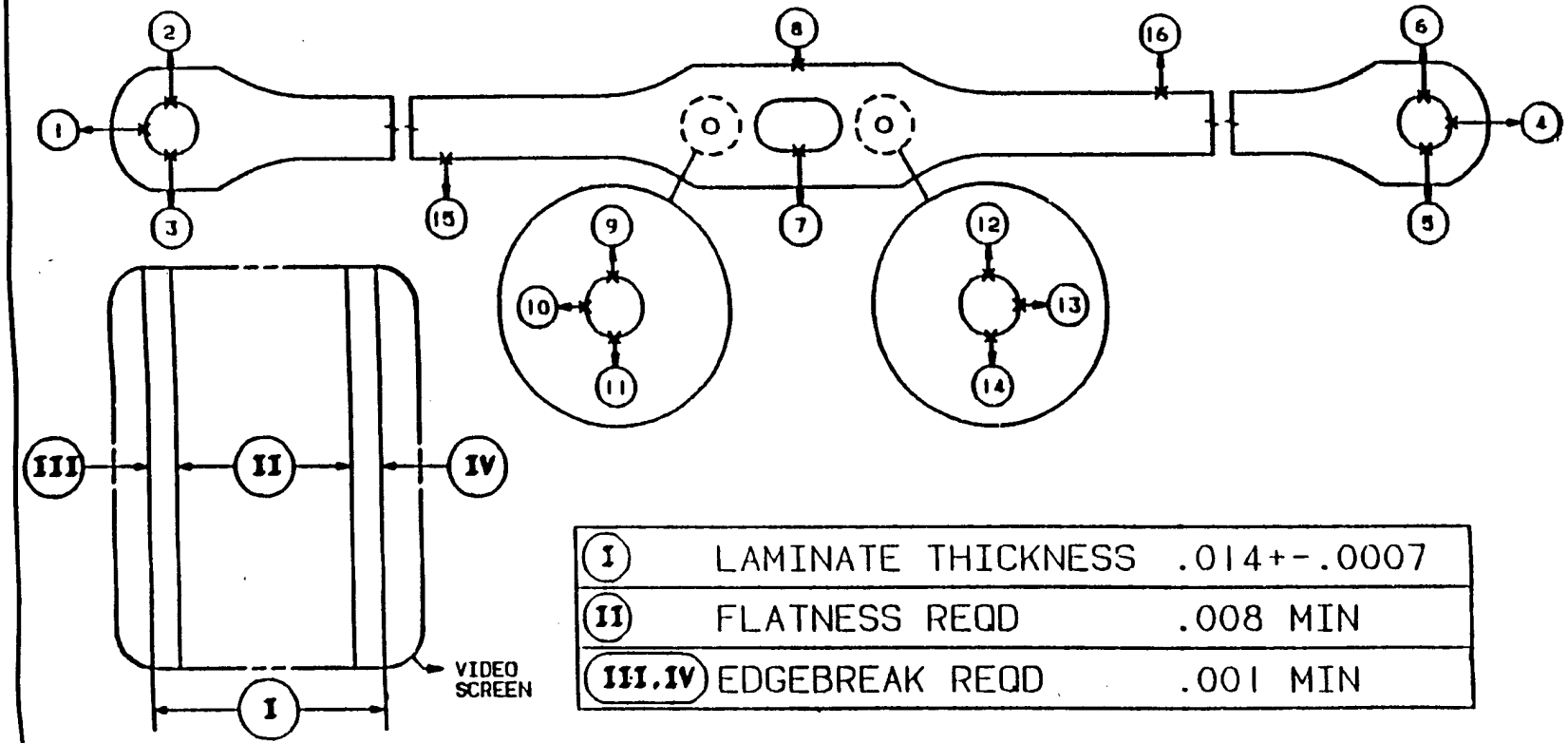
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.921	10.299							10.367	11.055
L - TOP							1.444	2.198							2.138	1.618
P - BOTTOM							1.992	1.550							1.833	1.496

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01418
S/N 1548-21 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

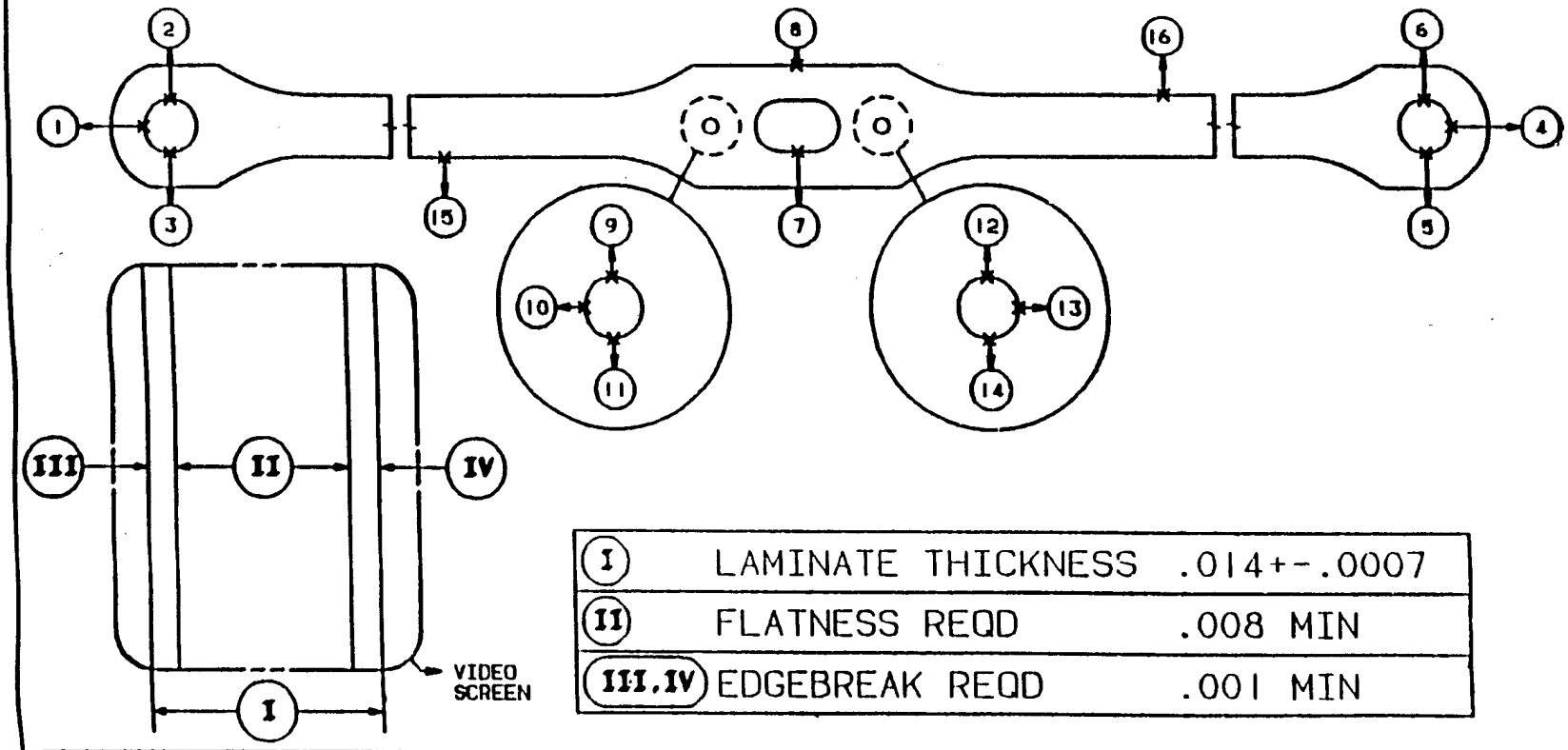
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.021	10.175							11.166	11.539
L - TOP							1.723	1.847							1.693	1.248
P - BOTTOM							2.394	1.899							1.343	1.496

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01412
S/N 1548-22



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.440	8.803							11.794	11.412
L - TOP							1.896	2.992							1.279	1.620
P - BOTTOM							1.730	2.065							1.280	1.123

NOTE NOT TO SCALE

Appendix C:

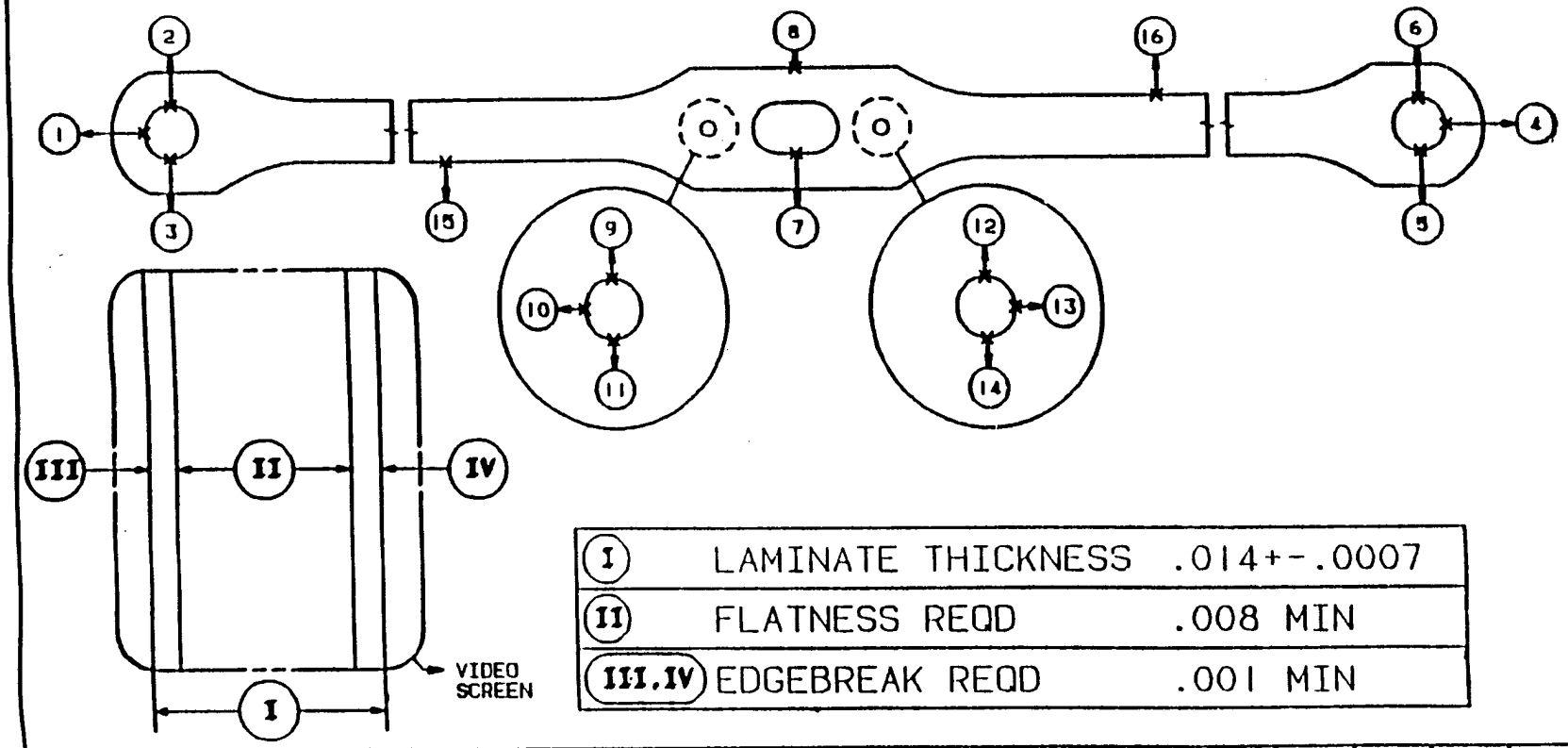
Edge Break Data for Strap Pack 1174

INTENTIONALLY LEFT BLANK.

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01442
S/N 1174-1



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

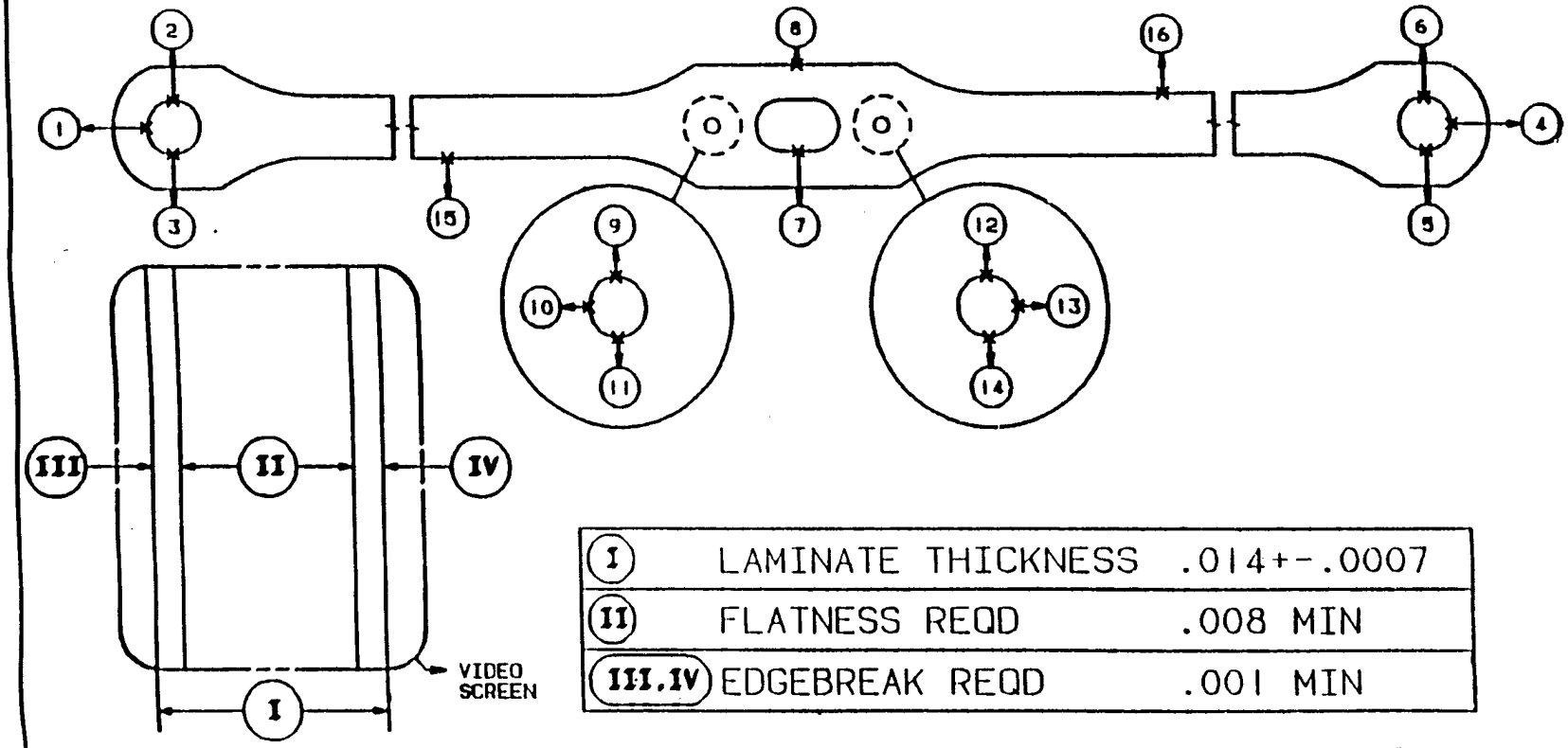
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.224	10.670							10.851	10.867
L - TOP							2.062	1.995							1.794	1.766
P - BOTTOM							2.170	1.820							1.969	1.874

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01430**
S/N **1174-2**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

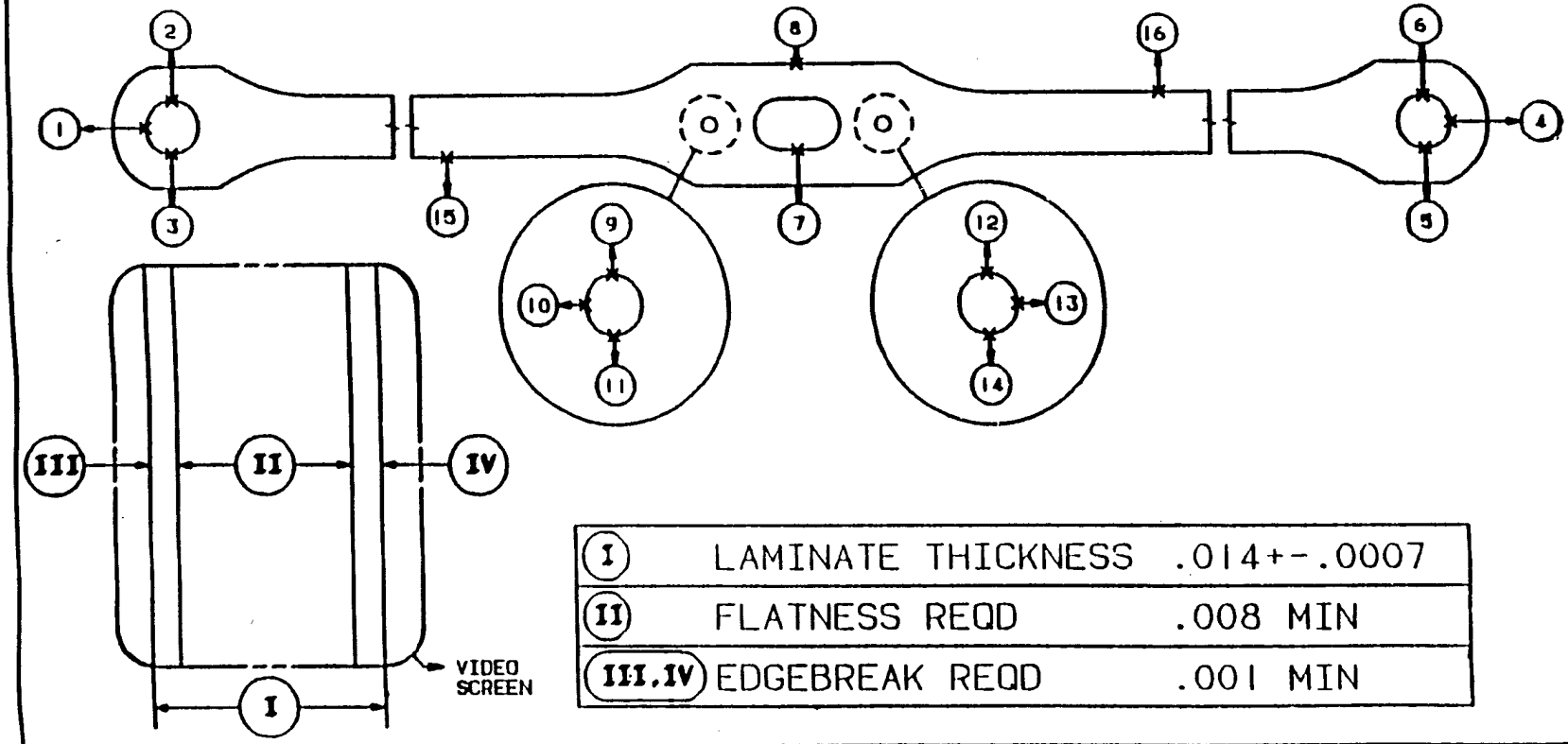
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.431	10.856							10.508	10.747
L - TOP							2.576	1.820							1.766	1.745
P - BOTTOM							2.476	1.809							2.158	1.854

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01429
S/N 1174-3



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

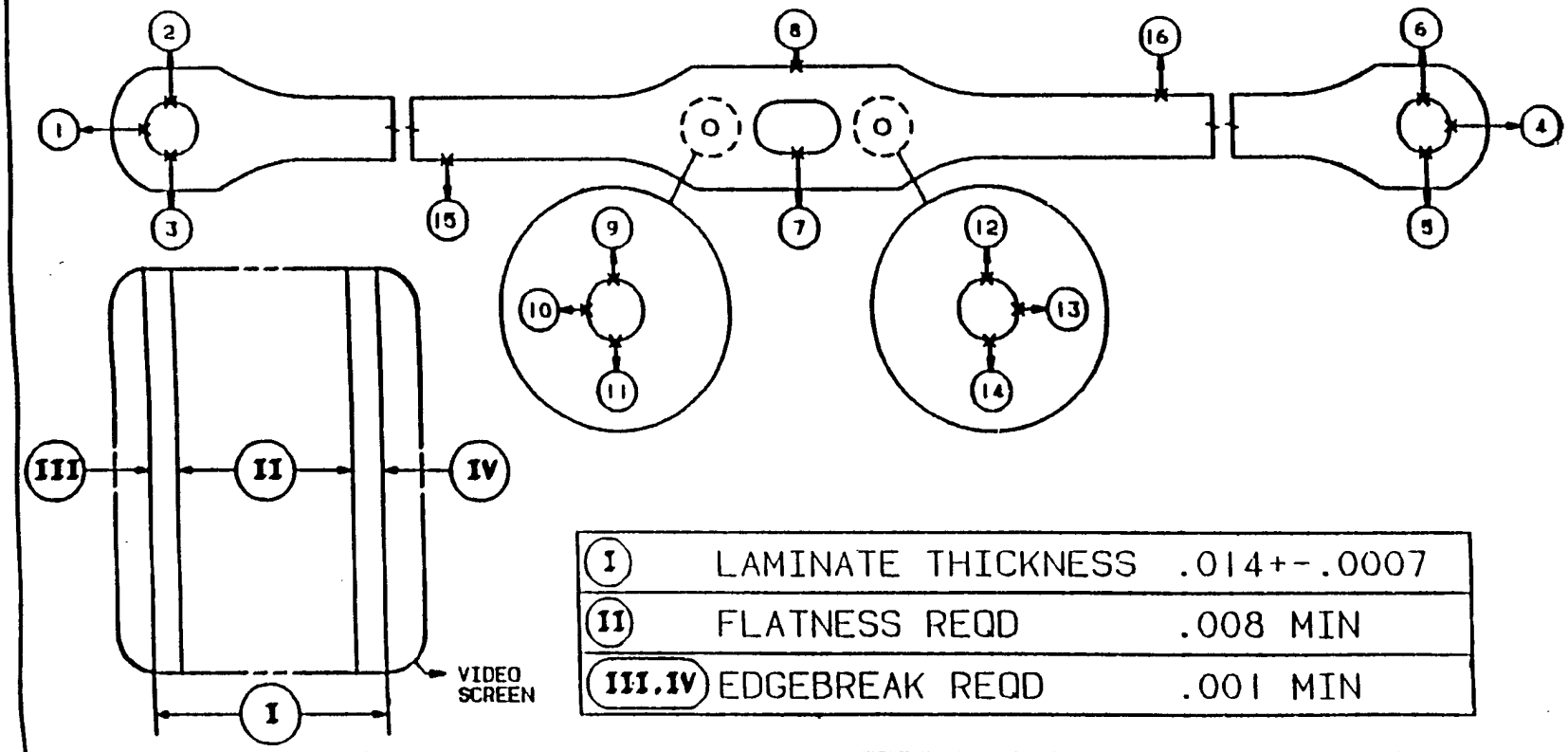
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.897	10.041							10.141	10.202
L - TOP							2.387	2.158							2.138	2.633
P - BOTTOM							2.305	2.158							2.212	1.565

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01422
S/N 1174-4



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

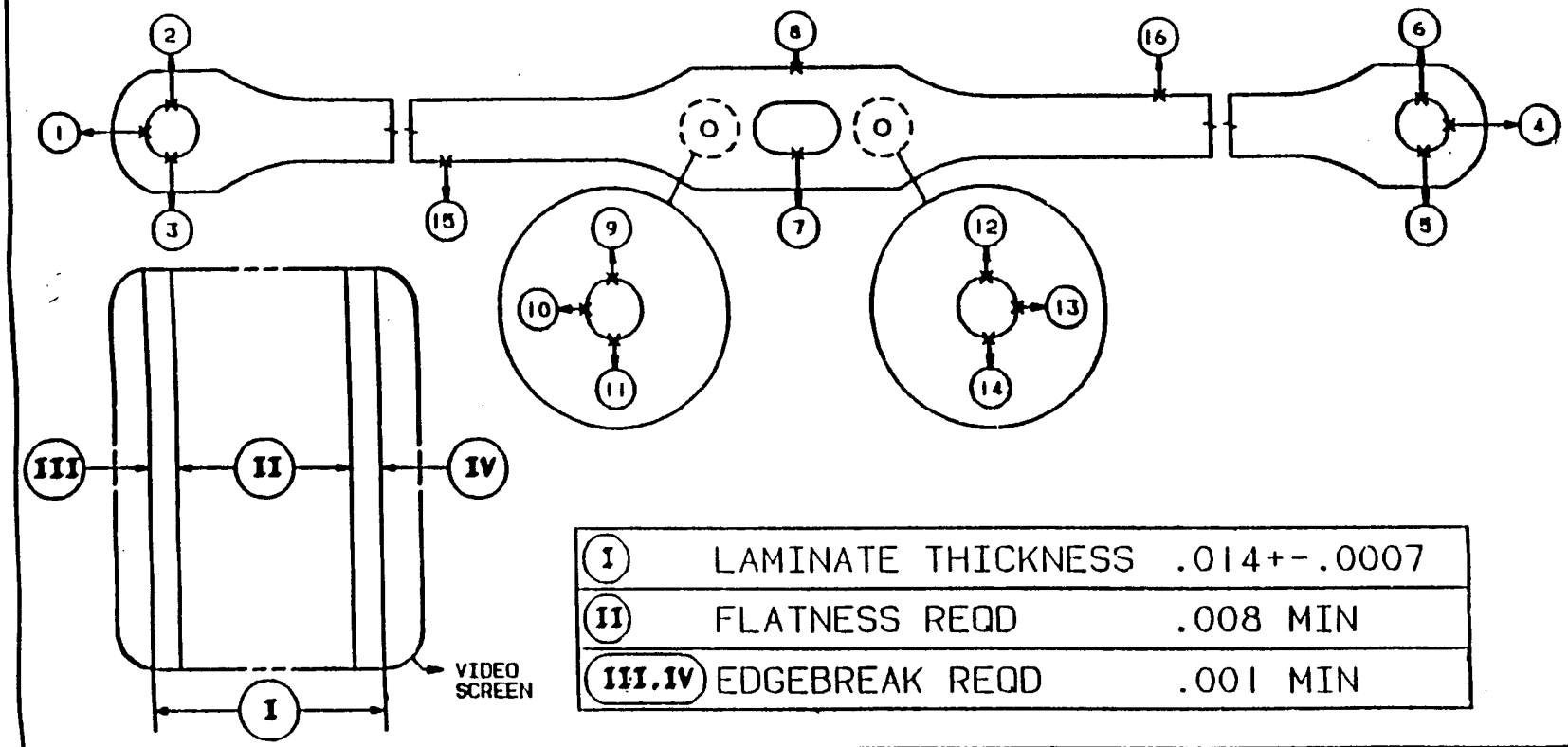
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.199	9.929							10.703	10.278
L - TOP							2.965	2.267							1.983	1.929
P - BOTTOM							2.212	2.049							1.874	2.107

NOTE: NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01428
S/N 1174-5



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

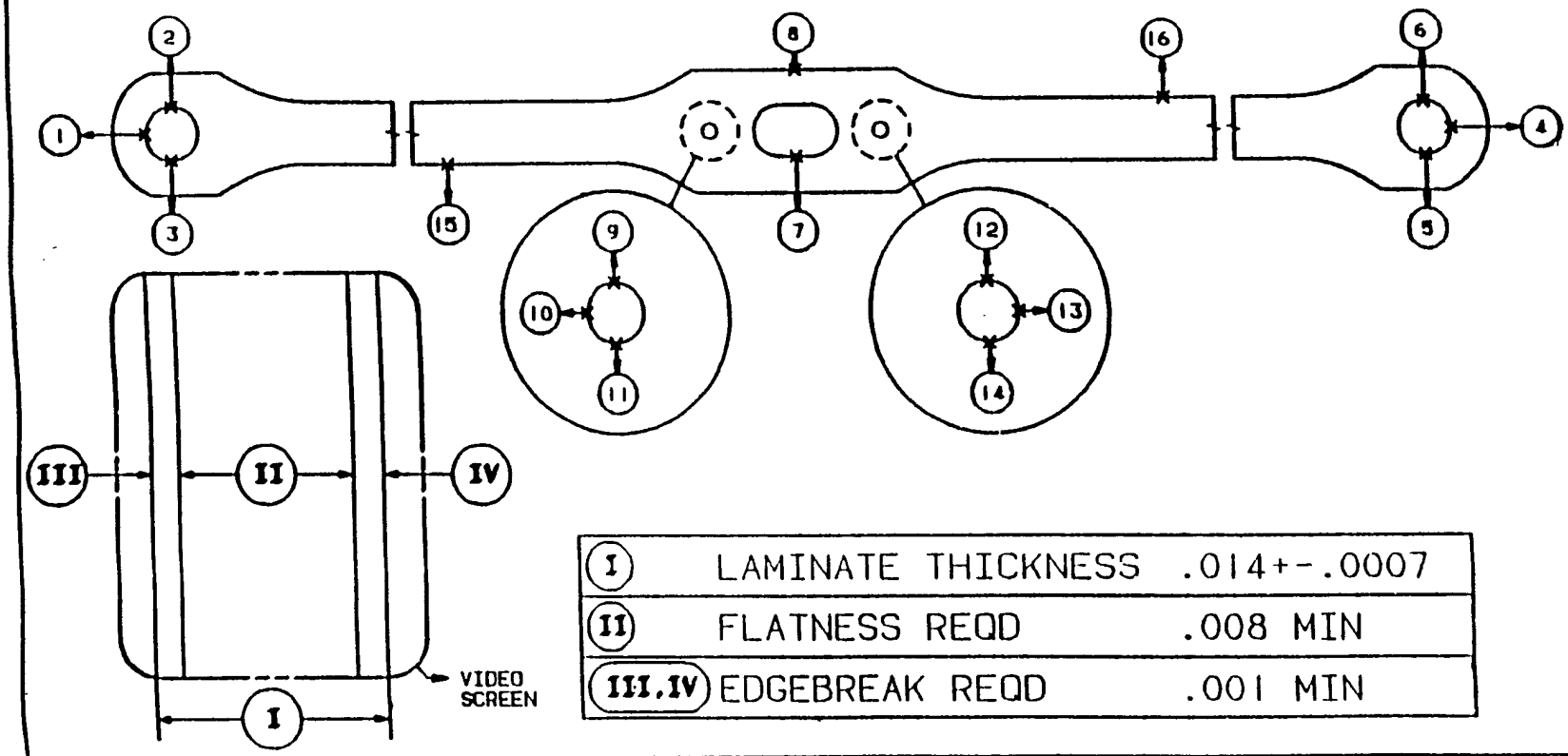
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS						9.182	9.803						9.986	8.785		
L - TOP						2.845	2.453						2.267	2.768		
P - BOTTOM						2.496	2.187						2.170	2.833		

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01428
S/N 1174-6 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

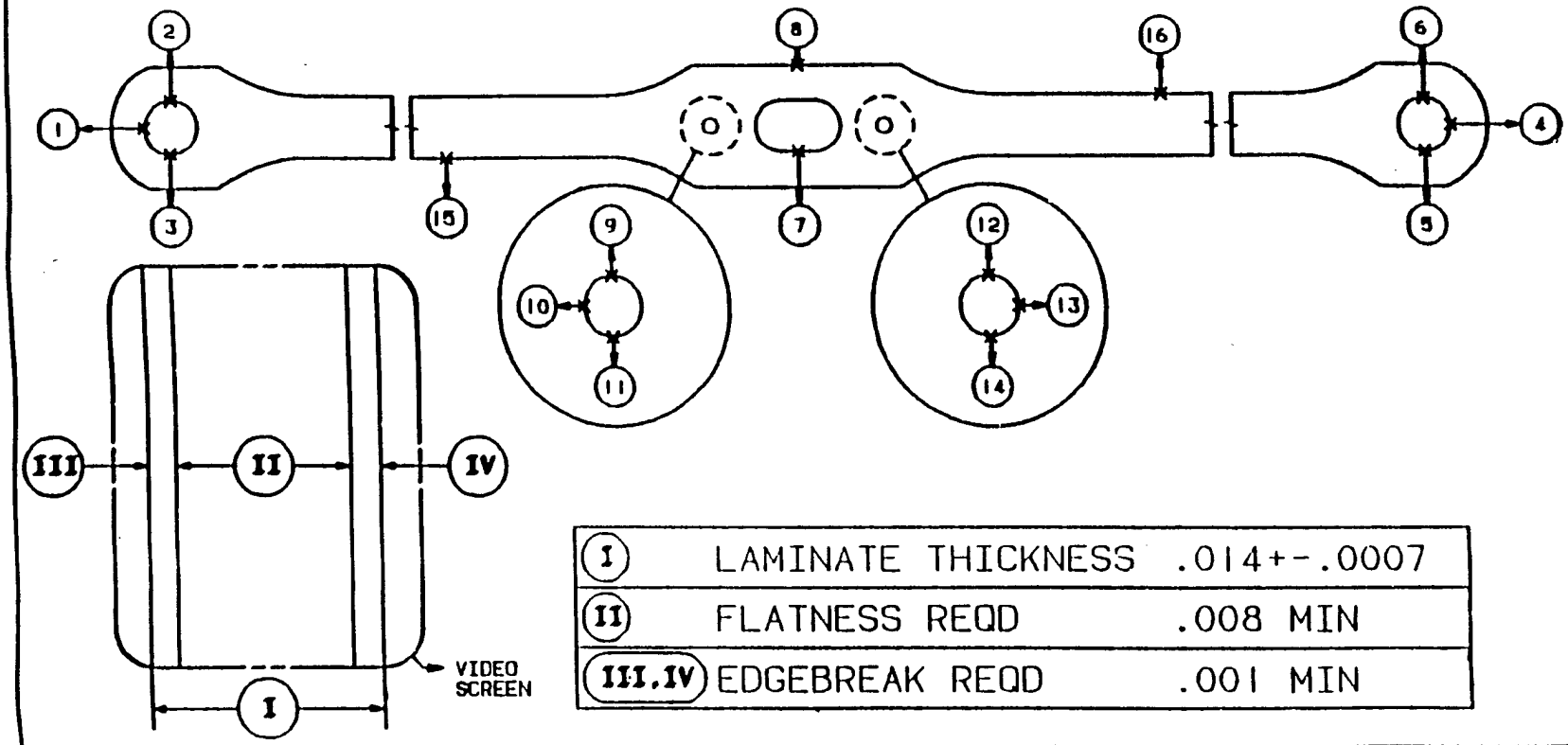
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.151	10.141							10.695	10.444
L - TOP							2.212	2.212							1.874	1.918
P - BOTTOM							2.158	2.116							1.883	2.158

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01448
S/N 1174-7



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.276	9.286							10.225	9.984
L - TOP							2.857	2.791							1.766	2.399
P - BOTTOM							2.147	2.441							2.387	2.116

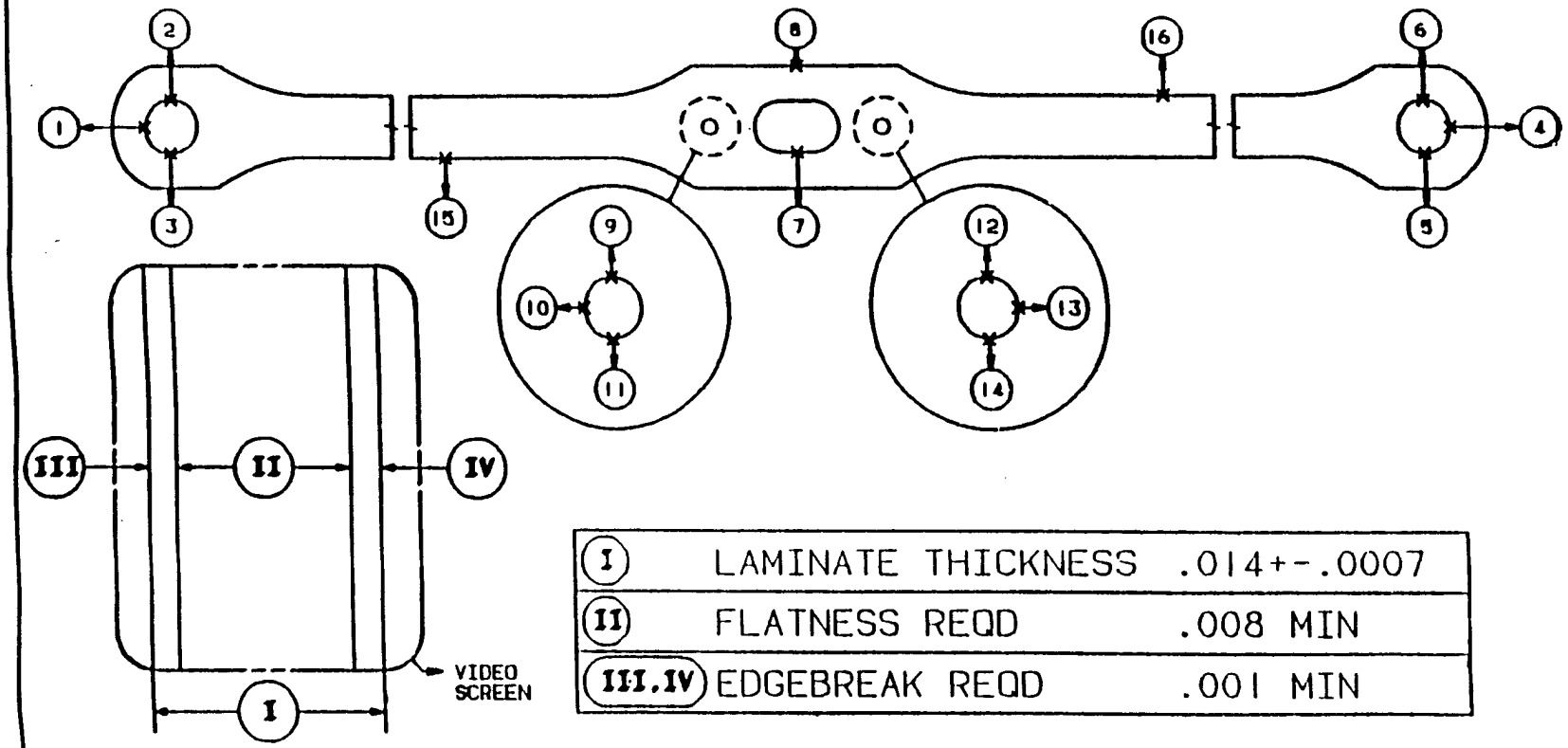
NOTE NOT TO SCALE

77

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01423**
S/N **1174-8** -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

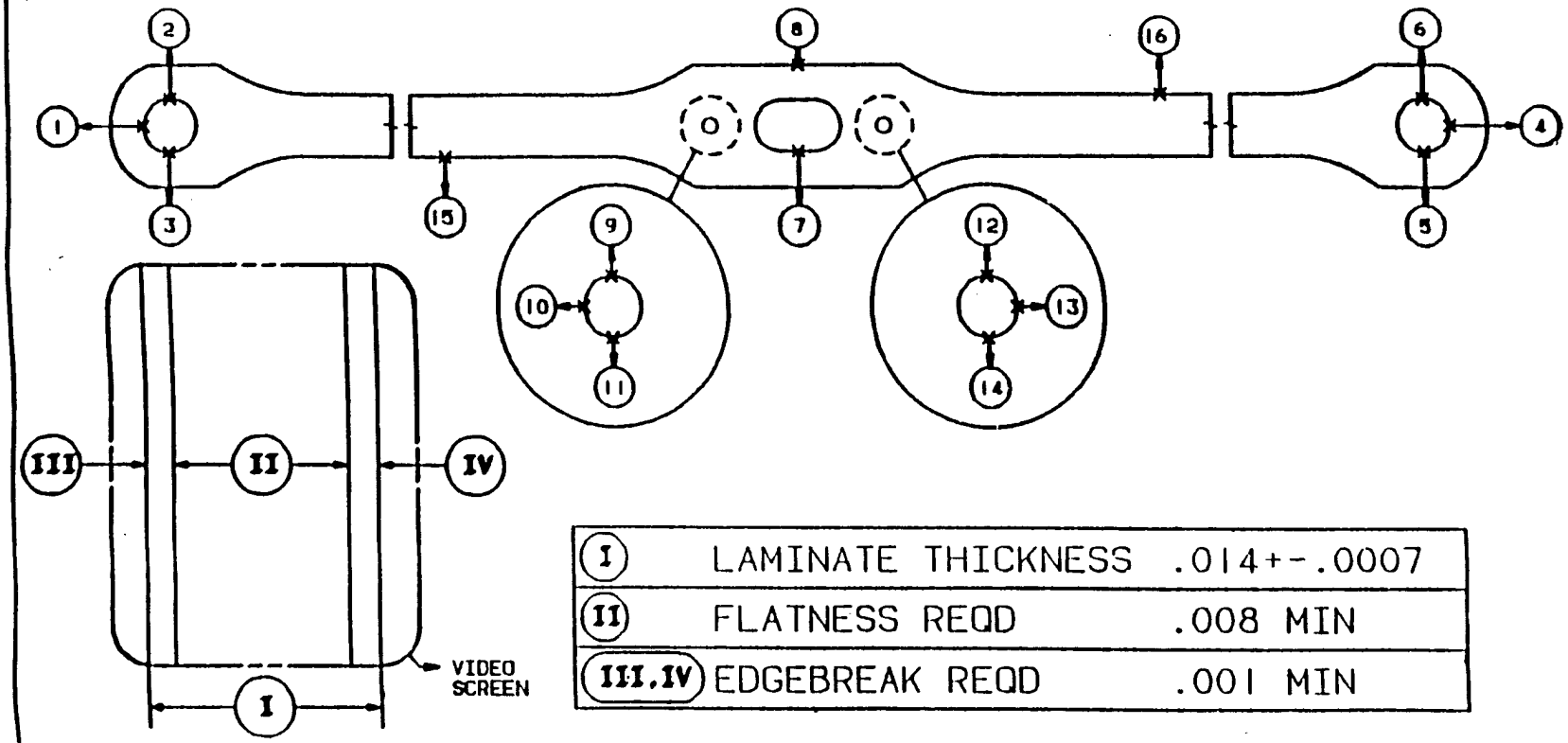
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.938	9.203							9.136	8.392
L - TOP							3.008	2.640							2.942	3.128
P - BOTTOM							2.670	2.531							2.267	2.953

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01425**
S/N **1174-9**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

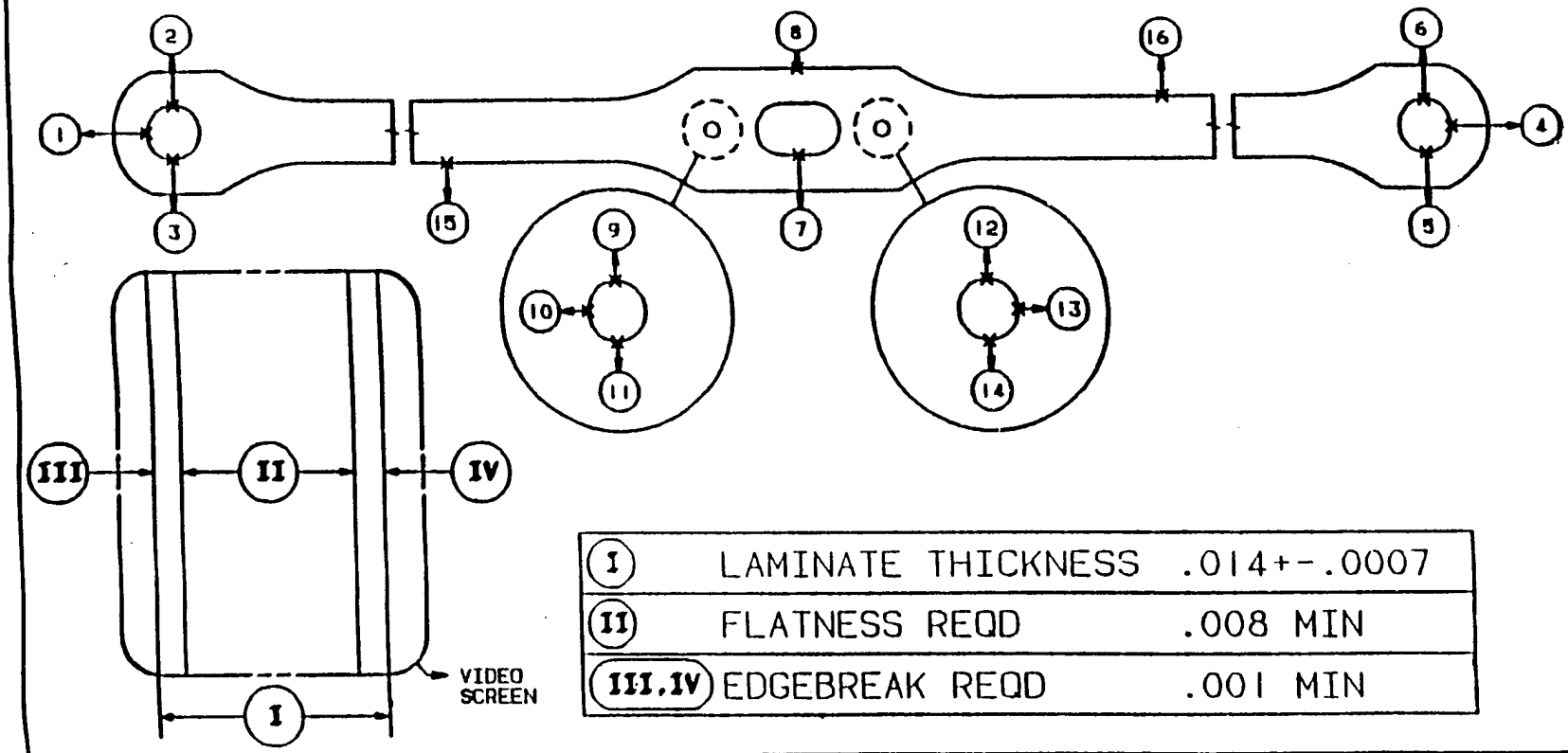
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.938	9.145							9.875	10.717
L - TOP							3.028	2.507							2.224	1.690
P - BOTTOM							2.441	2.585							2.507	1.887

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01424
S/N 1174-10 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

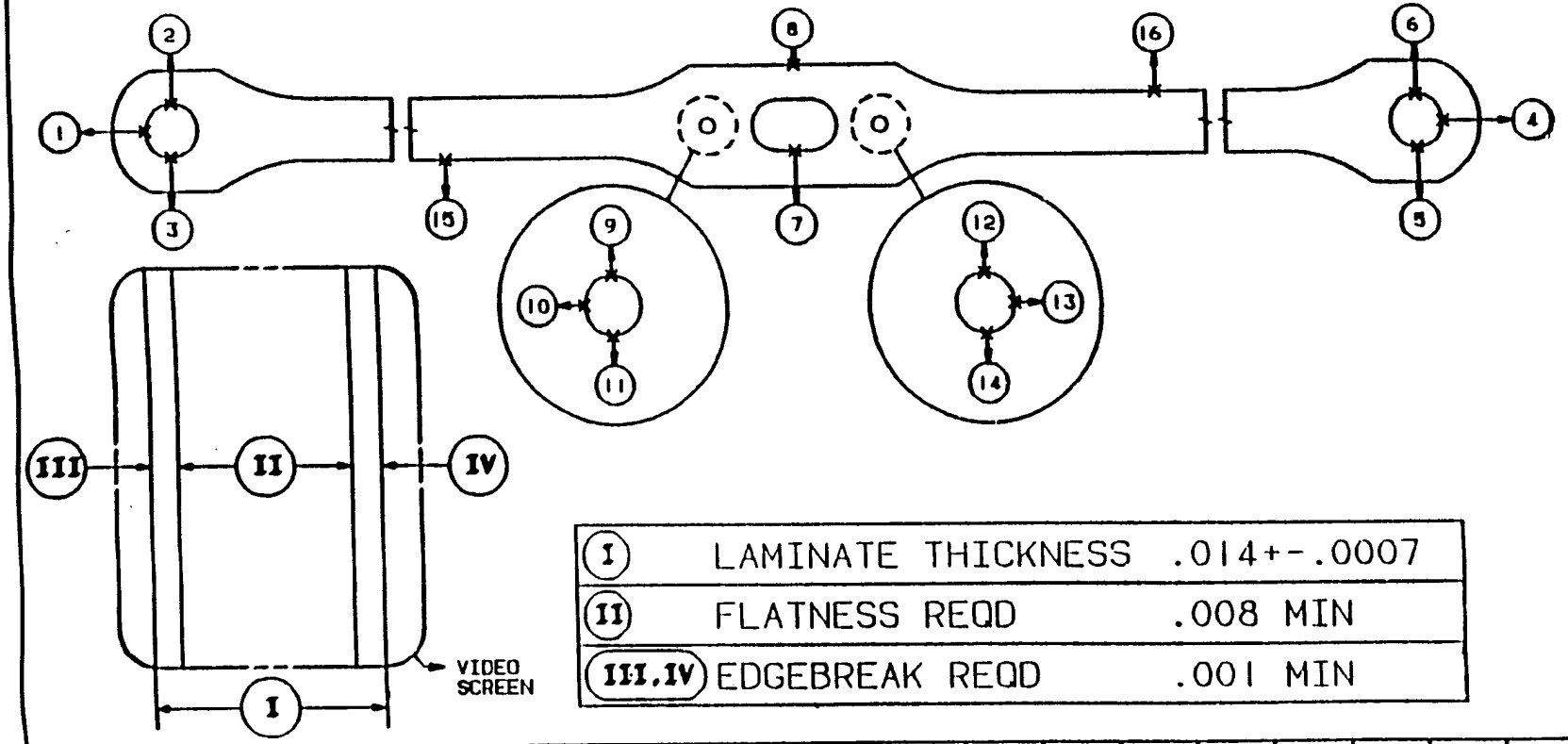
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							8.458	10.043							8.863	9.265
L - TOP							2.942	2.878							2.628	2.561
P - BOTTOM							2.854	2.441							2.710	2.540

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01430**
S/N **1174-11**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

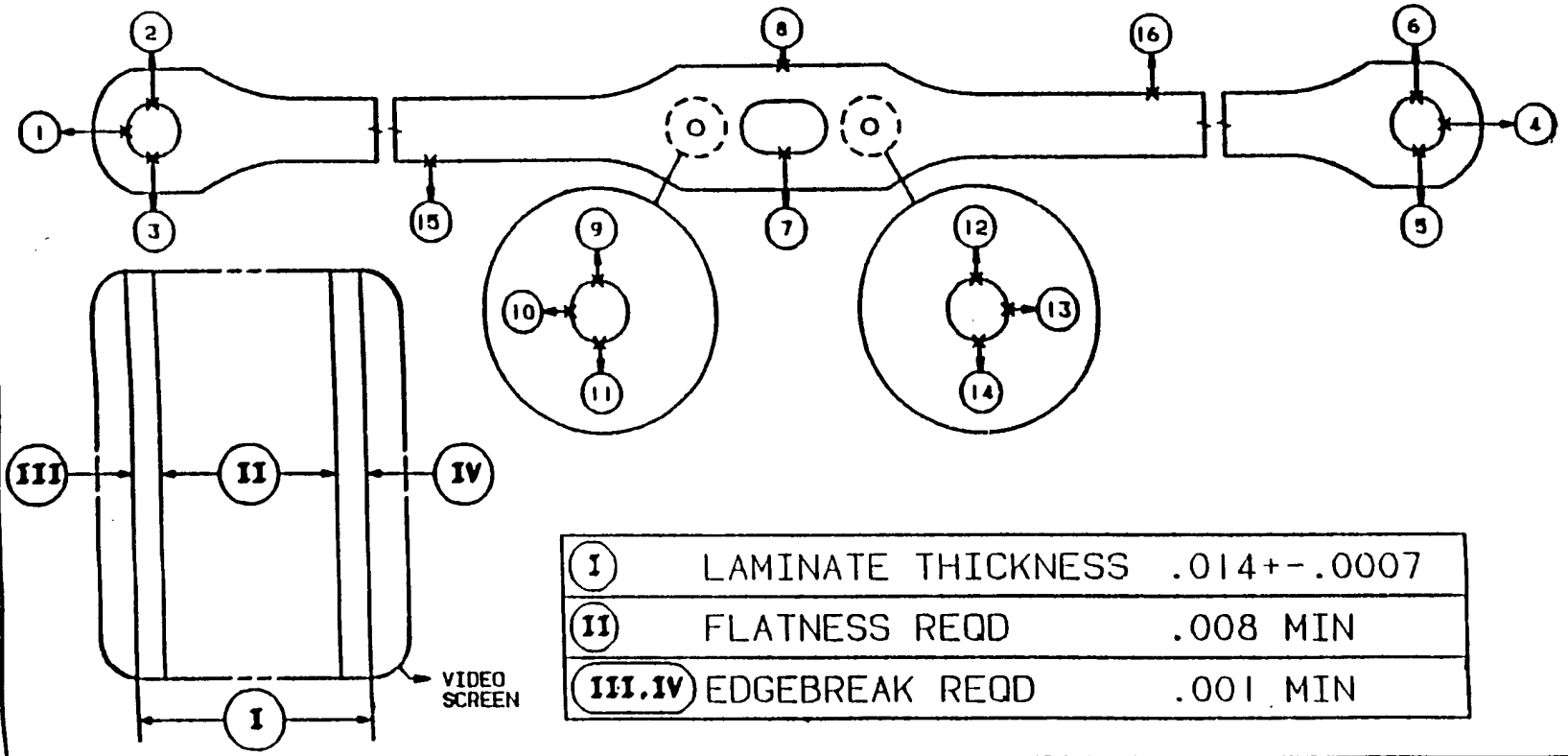
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.635	9.766							9.101	9.278
L - TOP							2.430	2.441							2.885	2.768
P - BOTTOM							2.453	2.224							2.561	2.427

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1174-12** _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

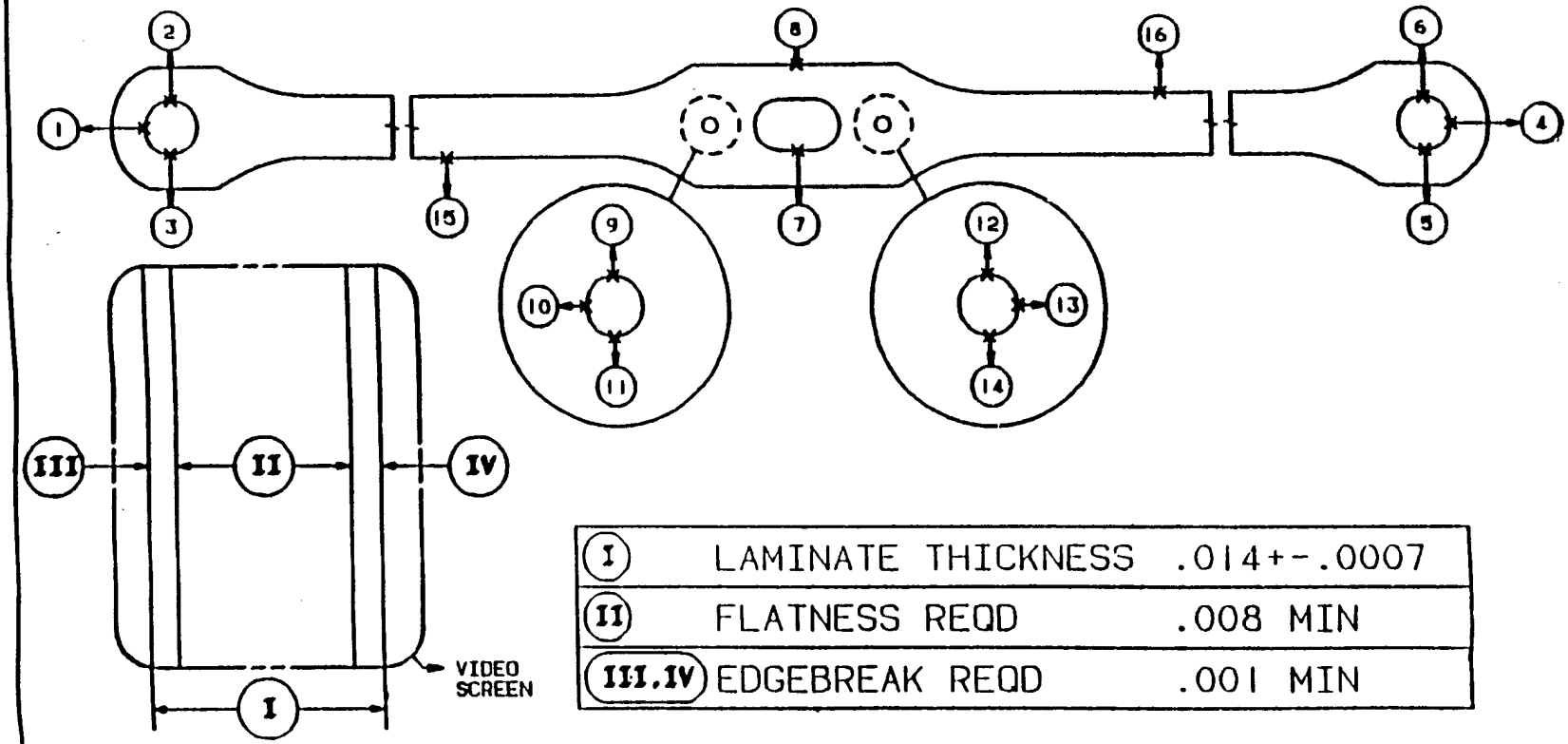
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.603	9.504							10.393	10.779
L - TOP							2.485	2.942							1.969	1.658
P - BOTTOM							2.485	2.212							2.130	1.954

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01425**
S/N **1174-13**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

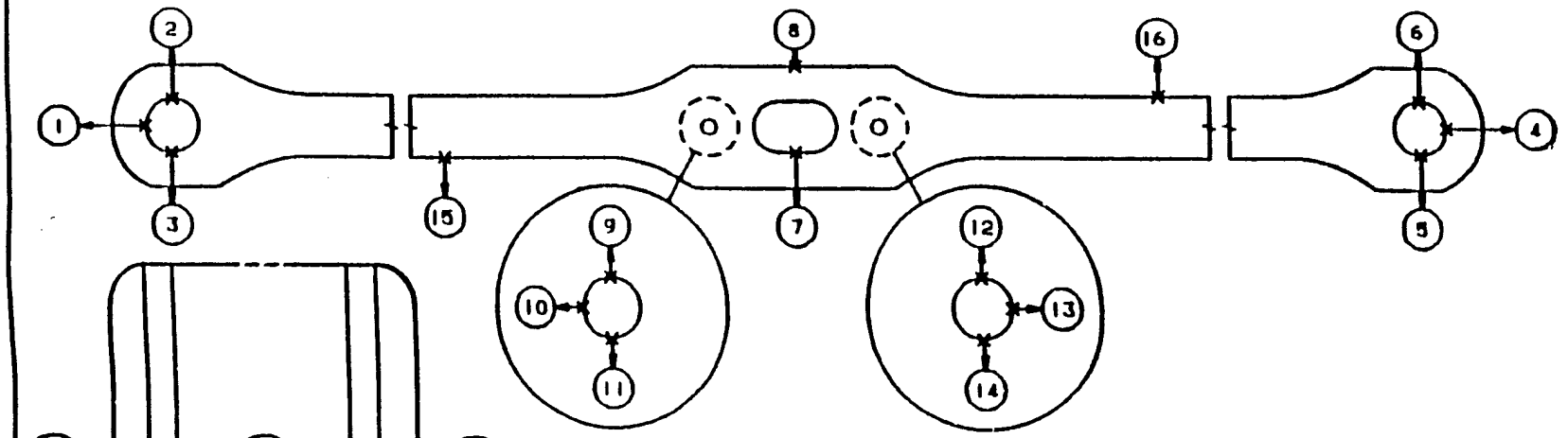
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.515	9.744							10.573	9.003
L - TOP							2.471	2.158							1.983	3.455
P - BOTTOM							2.642	2.466							2.062	1.941

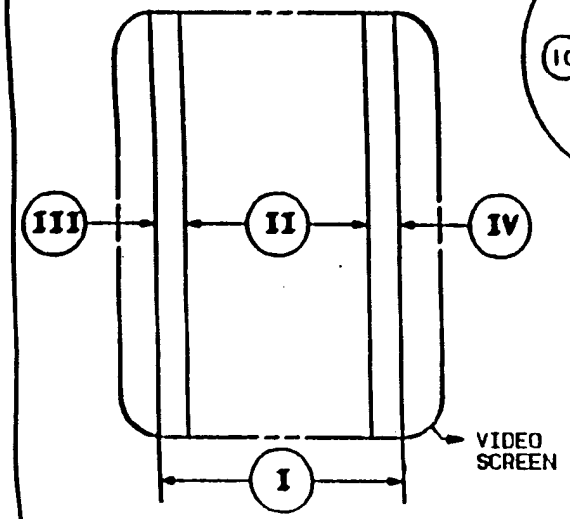
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01420
S/N 1174-14





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

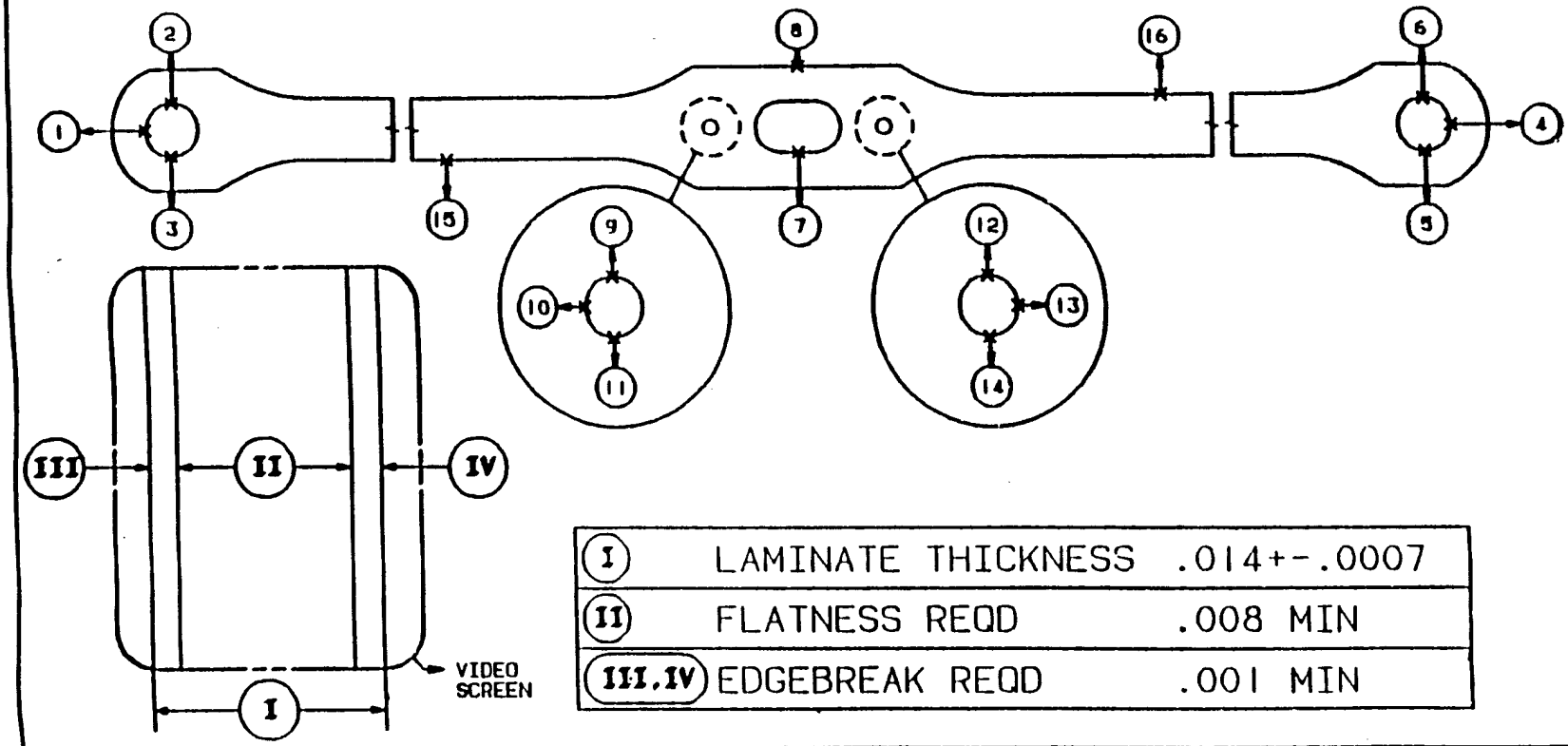
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.042	9.703							9.856	9.723
L - TOP							2.496	2.430							2.291	2.763
P - BOTTOM							2.103	2.278							2.237	2.166

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01425
S/N 1174-15



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

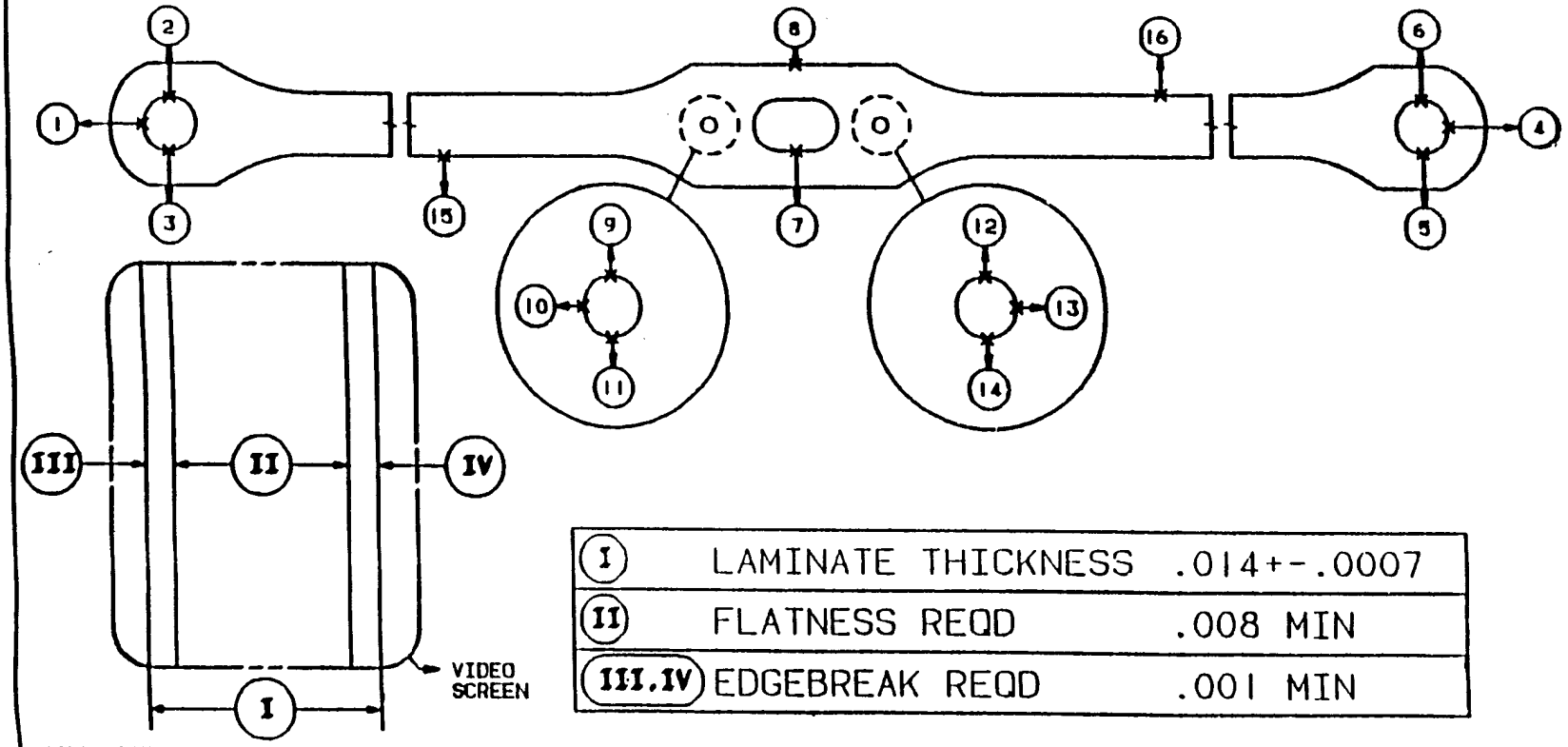
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.689	9.585							10.504	10.627
L - TOP							2.399	2.768							1.864	1.766
P - BOTTOM							2.430	2.125							2.049	1.995

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01432
S/N 1174-16



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

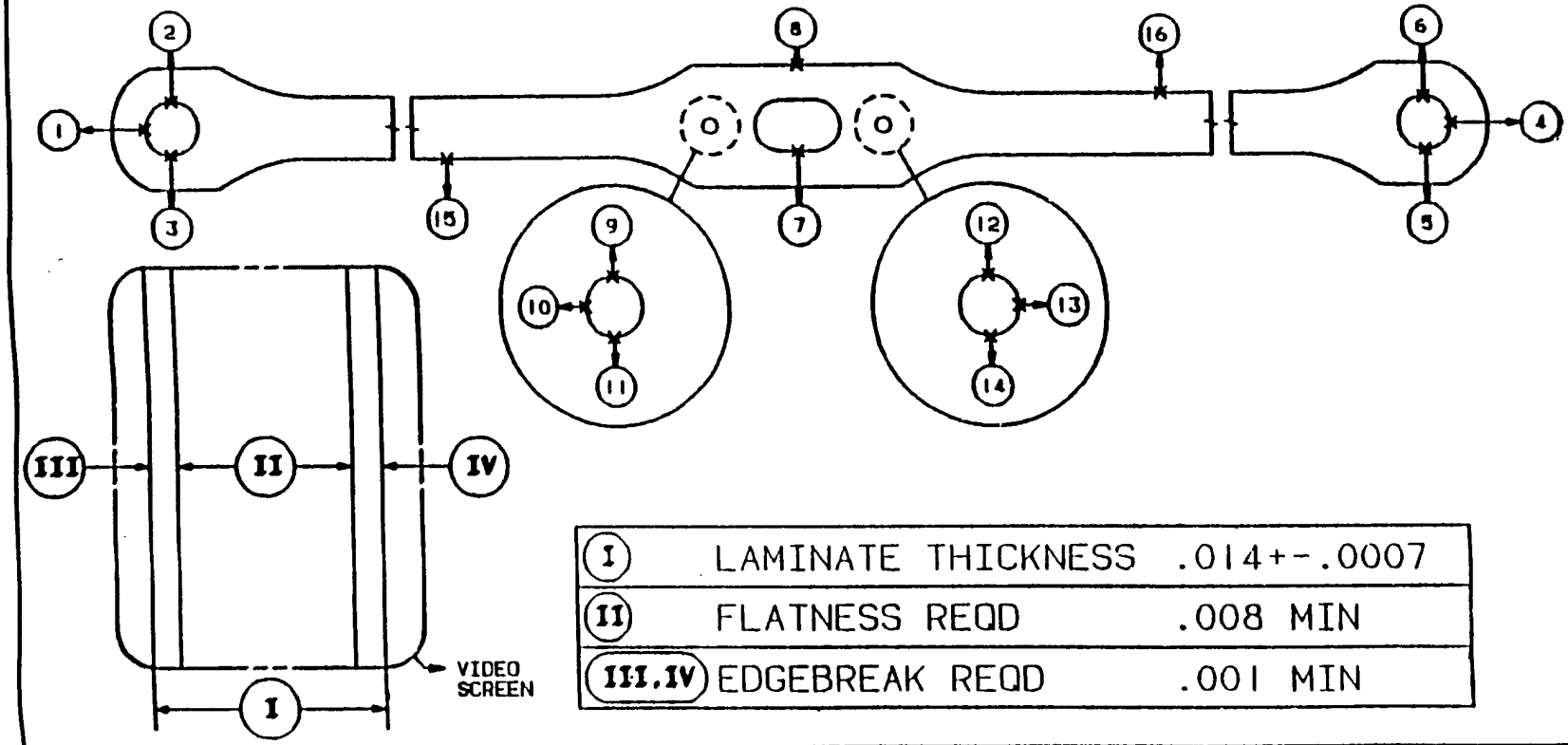
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.646	9.703							10.659	10.638
L - TOP							2.682	2.594							1.658	1.537
P - BOTTOM							2.345	2.376							2.345	2.412

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01425
S/N 1174-17 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

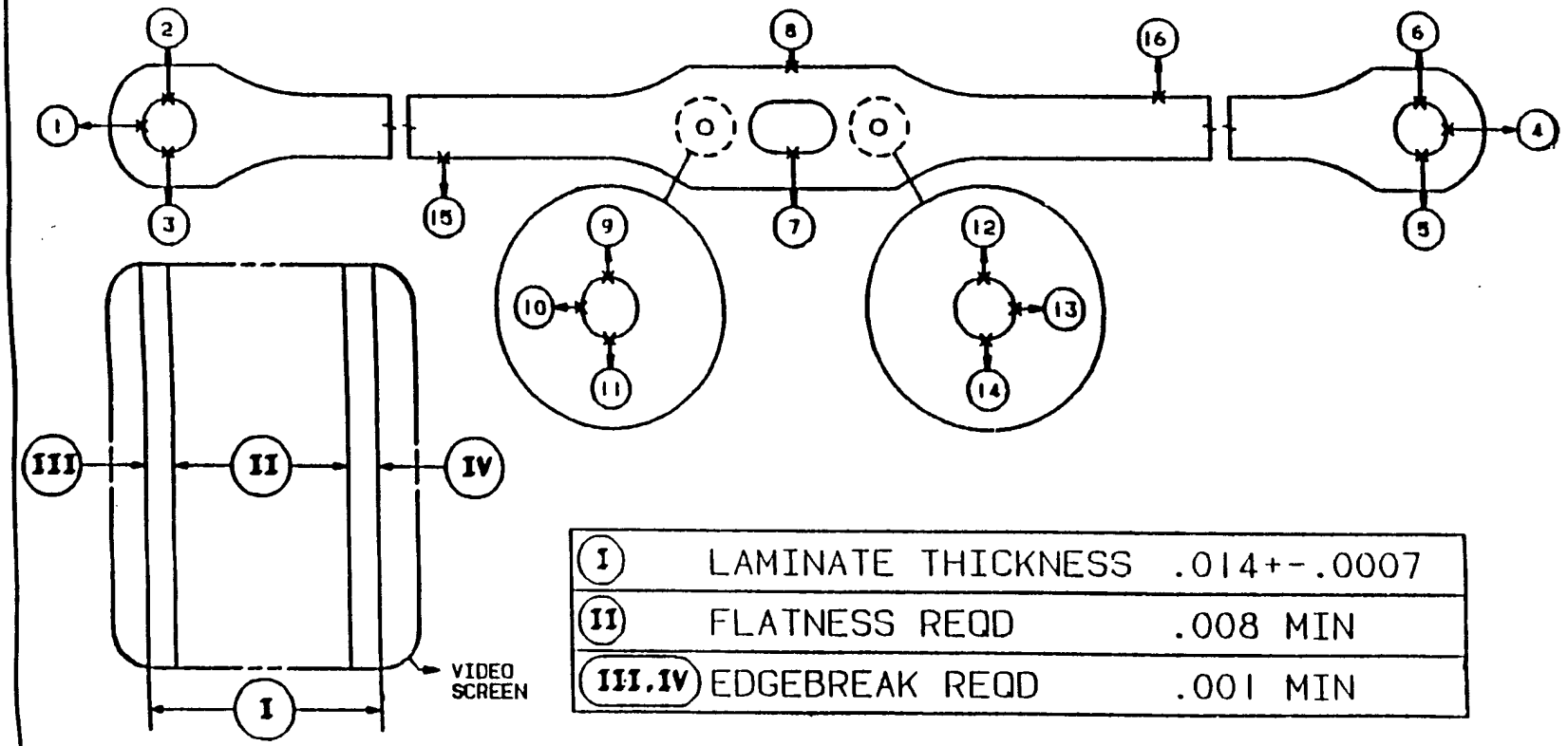
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.434	9.651							10.836	11.041
L - TOP							2.092	2.267							1.973	1.833
P - BOTTOM							1.995	2.461							1.887	1.671

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01424
S/N 1174-18 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

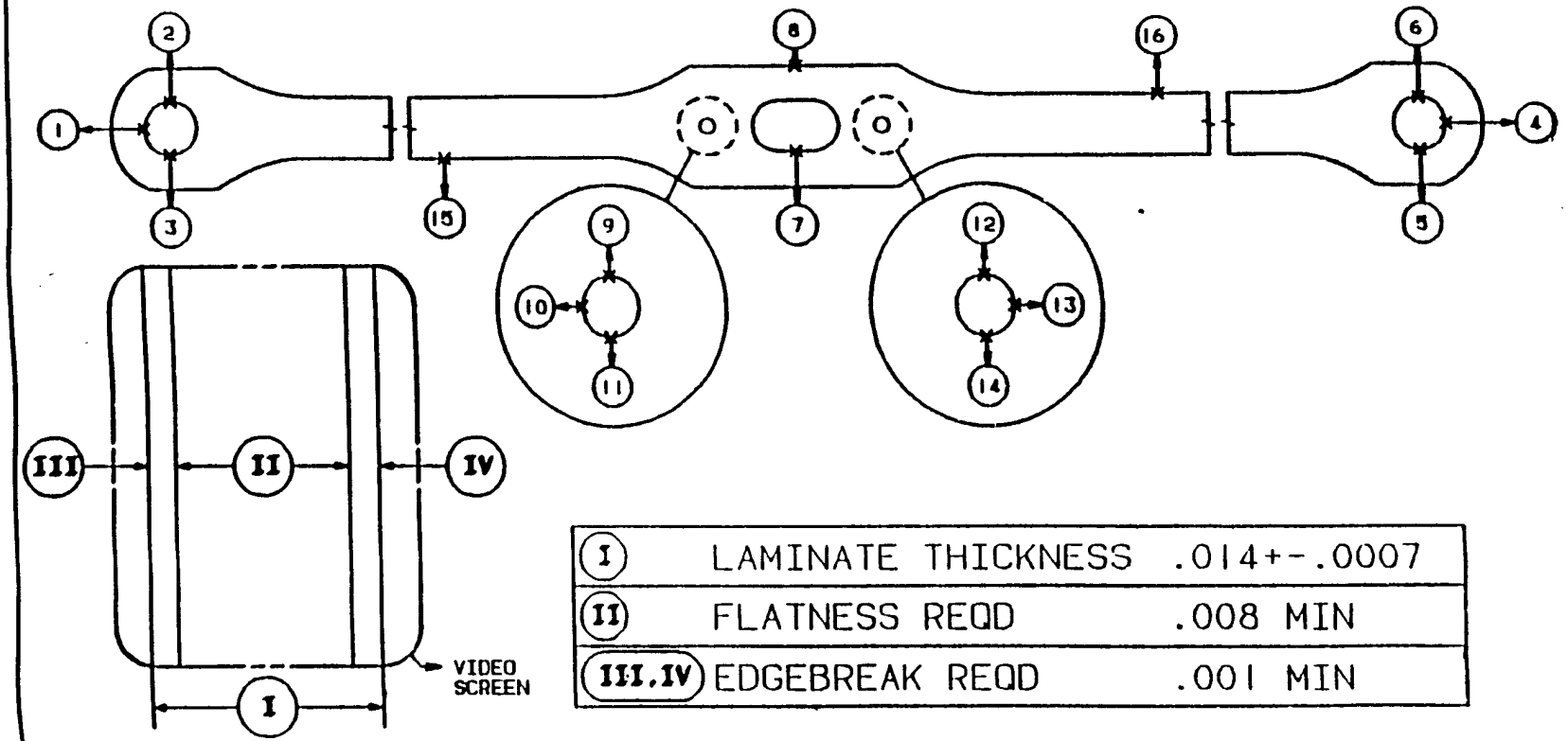
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.986	9.429							10.638	10.694
L - TOP							2.158	2.485							2.076	1.779
P - BOTTOM							2.224	2.427							1.766	2.076

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01423
S/N 1174-19 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

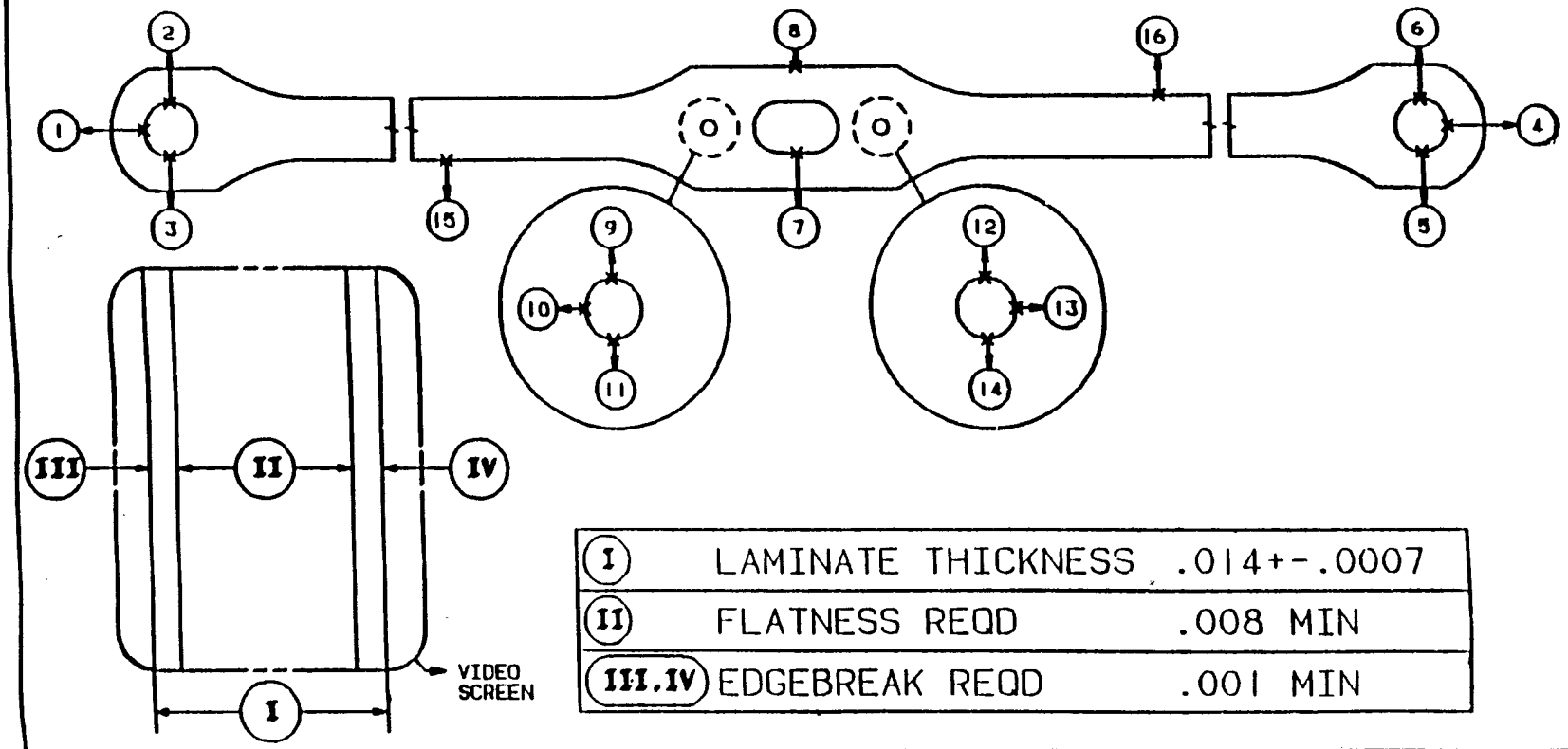
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.723	9.246							10.270	9.981
L - TOP							2.332	2.649							2.278	2.496
P - BOTTOM							2.321	2.749							1.995	1.841

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01425
S/N 1174-20



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

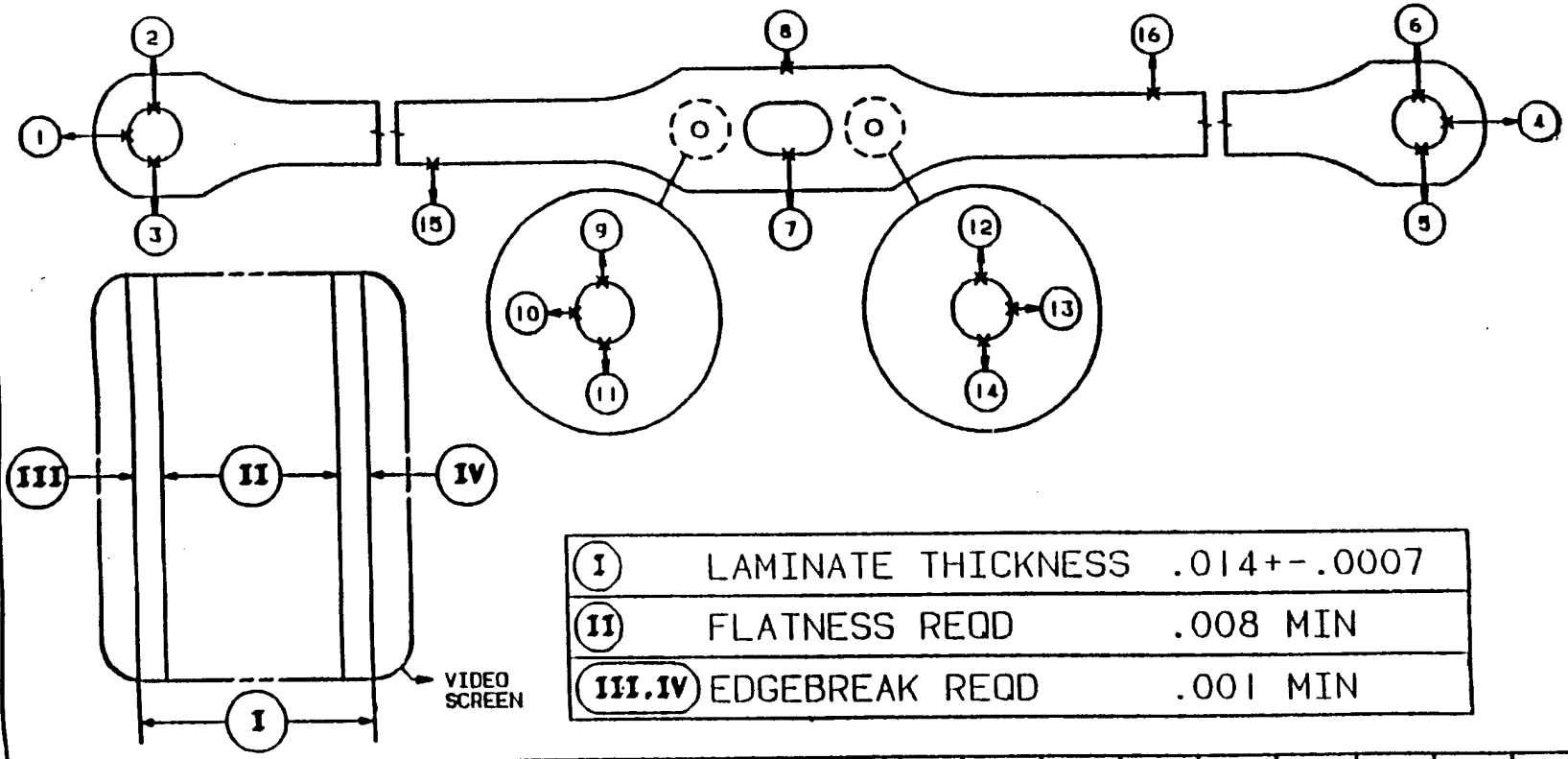
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.037	9.145							10.379	9.515
L - TOP							2.441	2.803							1.983	1.995
P - BOTTOM							2.791	2.453							2.183	3.128

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01420
S/N 1174-21



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

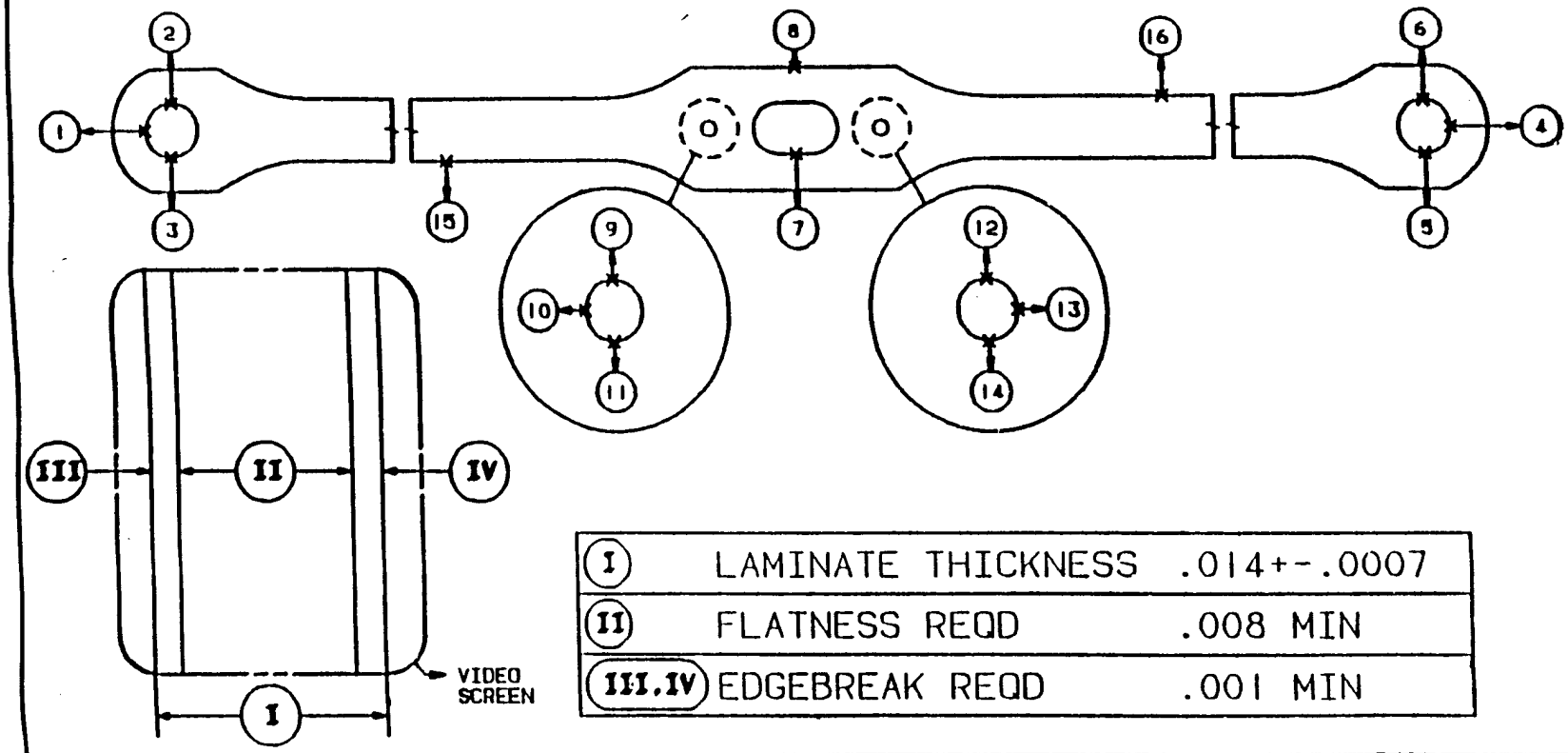
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.526	10.235							9.572	10.224
L - TOP							2.278	1.820							2.845	2.183
P - BOTTOM							2.345	2.376							2.103	1.929

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01420
S/N 1174-22



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.398	10.460							10.290	10.201
L - TOP							2.235	2.116							2.359	1.820
P - BOTTOM							1.995	1.954							1.901	2.252

NOTE NOT TO SCALE

Appendix D:

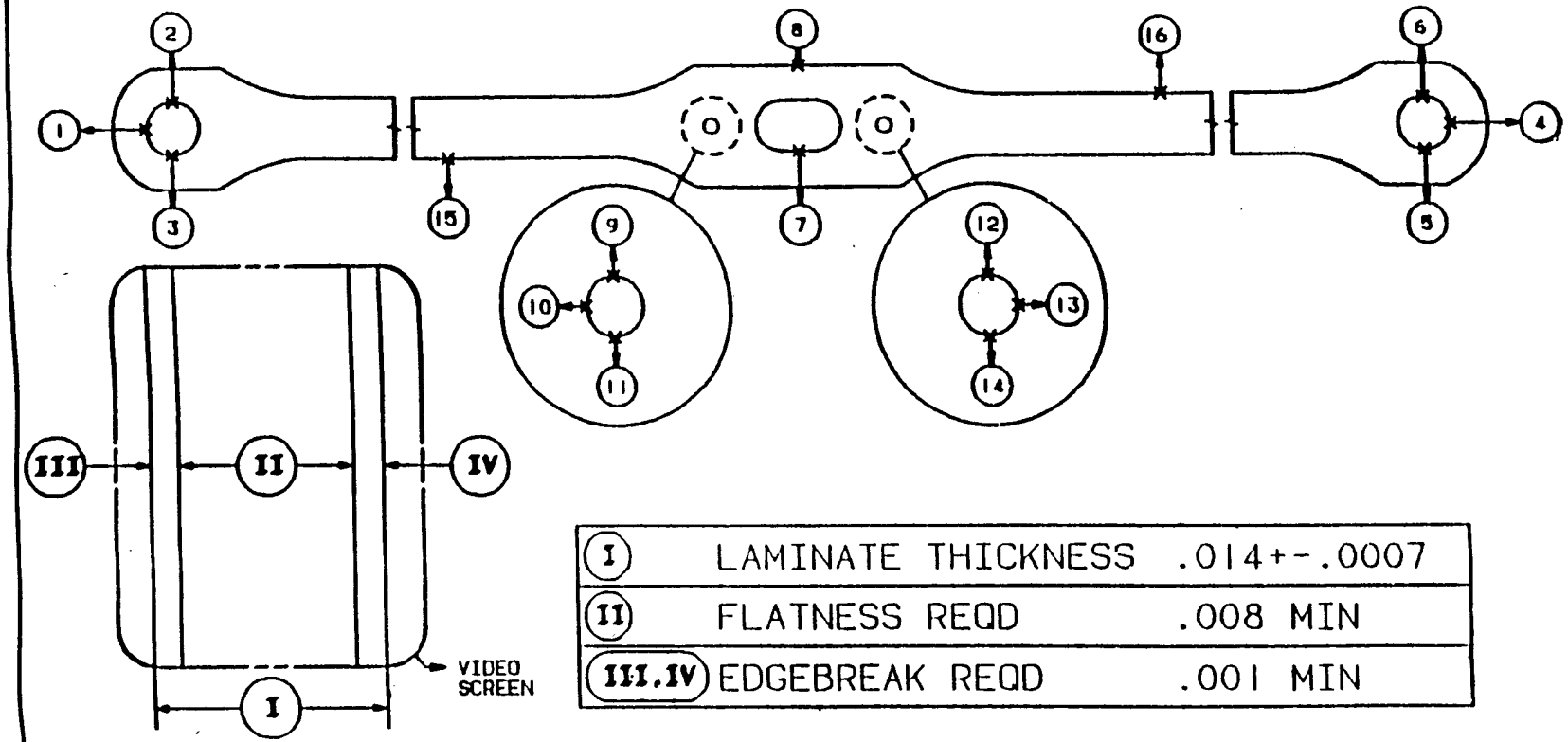
Edge Break Data for Randomly Selected Strap Pack Laminates From Packs 1167–1177 and Two "Extra" Laminates

INTENTIONALLY LEFT BLANK

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 OF page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01445
S/N 1167-1



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

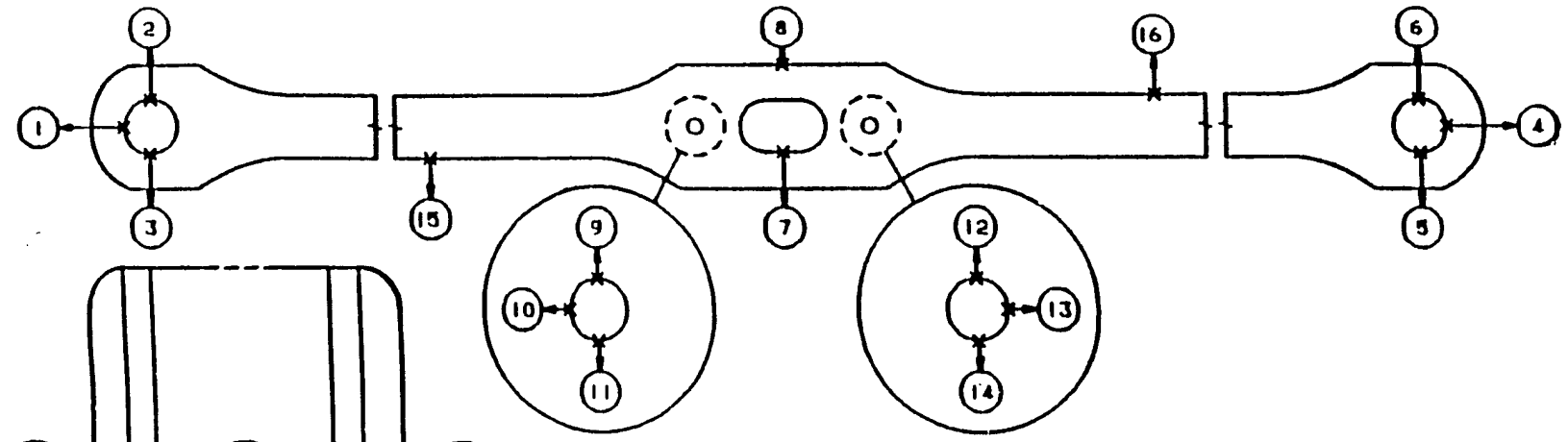
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.850	10.167							10.242	10.783
L - TOP							2.185	2.352							2.278	2.075
P - BOTTOM							2.750	1.976							1.909	1.704

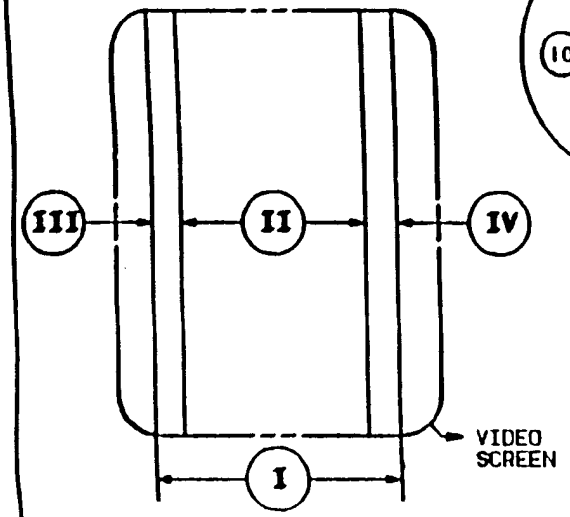
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01440**
S/N **1167-8**





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

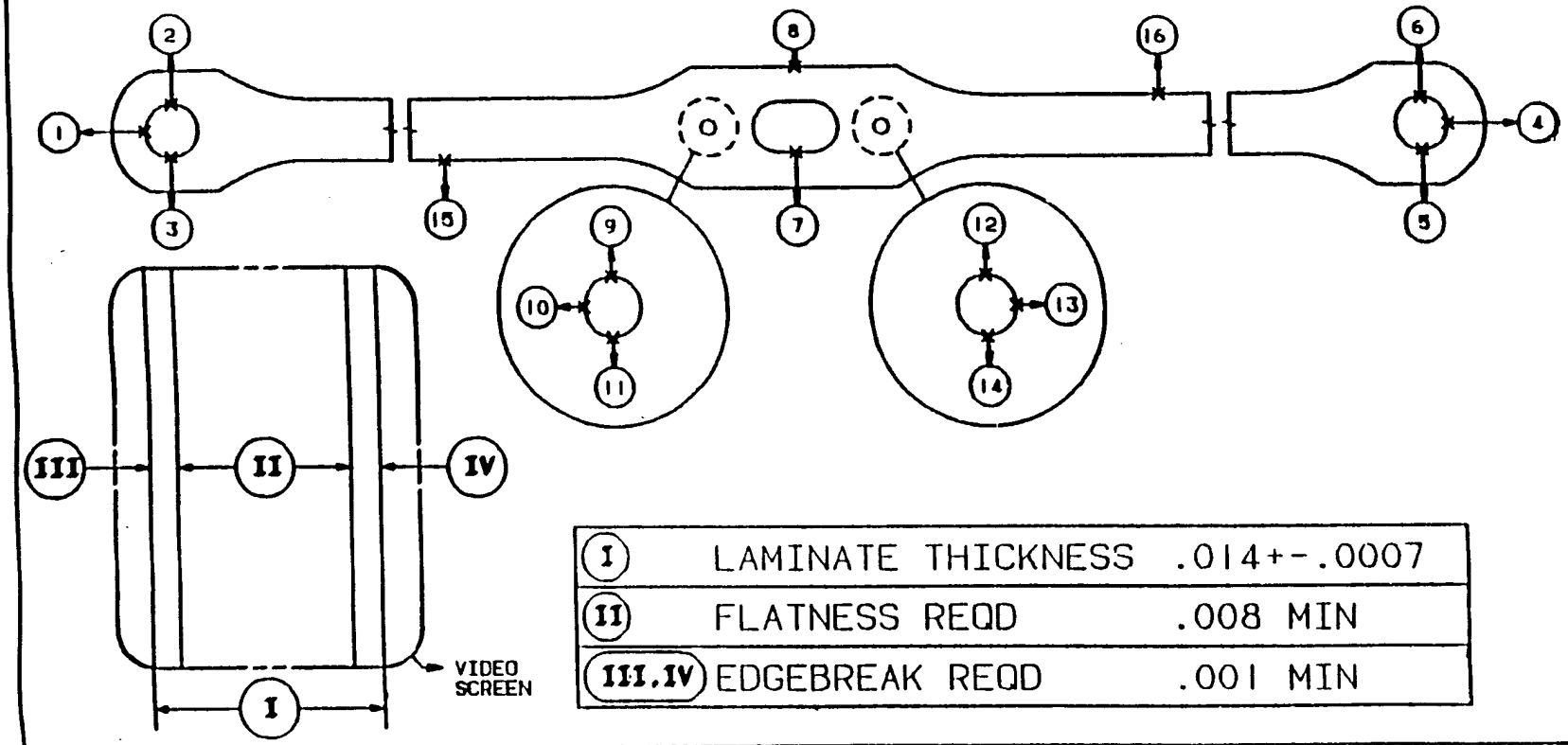
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.630	10.492							10.492	10.423
L - TOP							2.147	2.072							2.138	2.019
P - BOTTOM							2.531	1.854							2.083	2.075

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01440**
S/N **1167-20**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

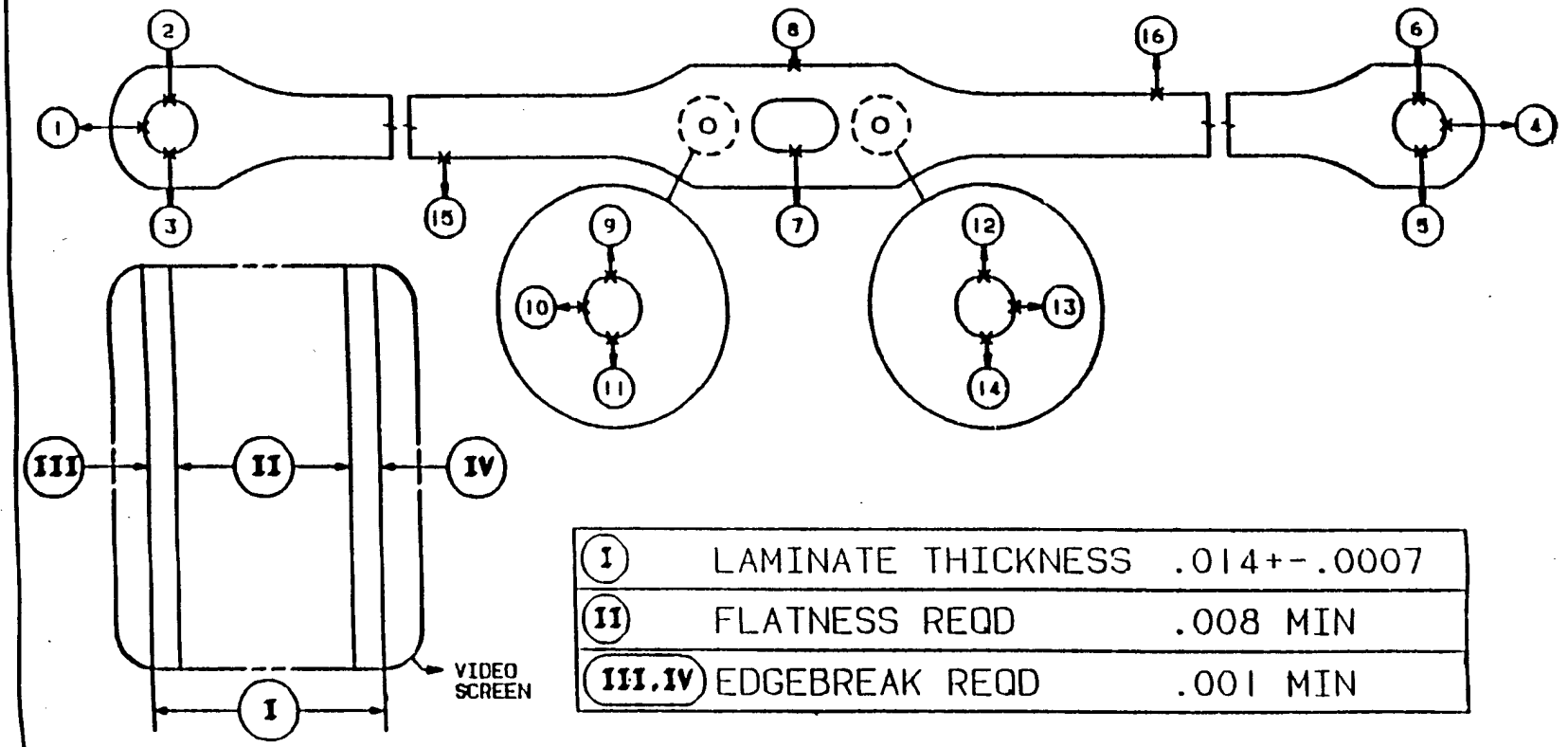
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.646	9.575							9.025	11.028
L - TOP							2.441	2.605							2.791	1.626
P - BOTTOM							2.453	2.202							2.682	1.973

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01455**
S/N **1168-3**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

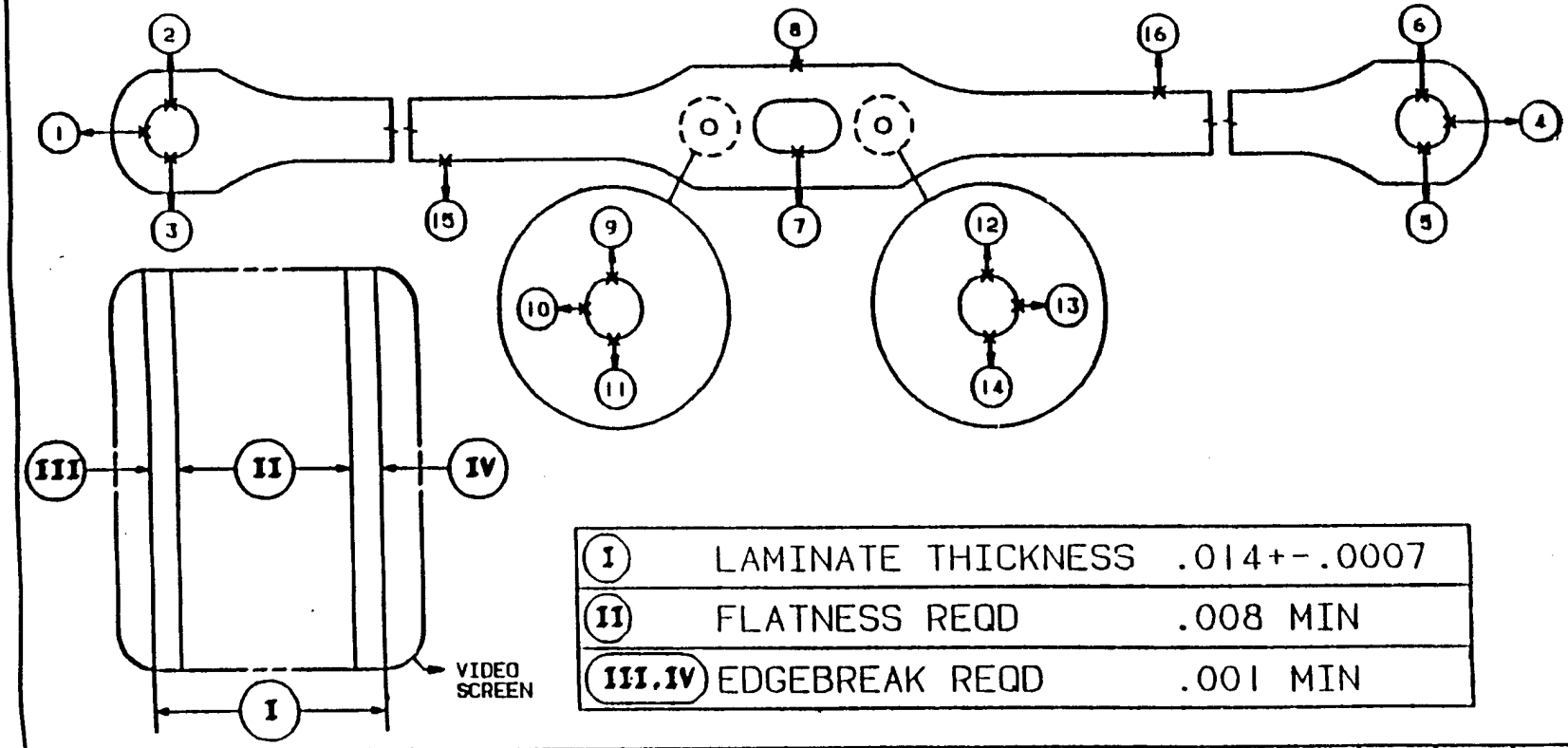
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.558	9.657							9.588	10.555
L - TOP							2.198	2.453							2.794	1.954
P - BOTTOM							1.779	2.704							2.252	2.008

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1168-12**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

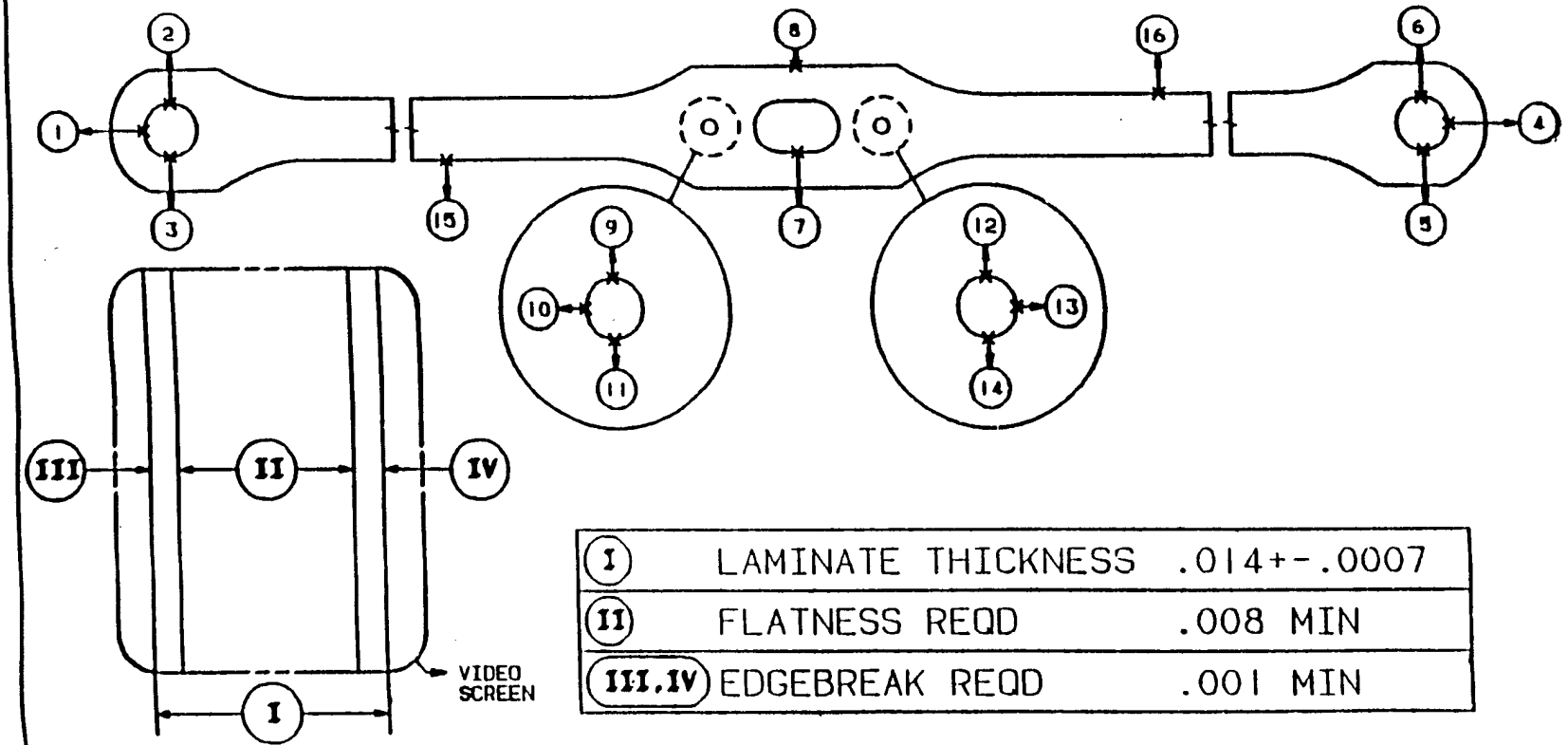
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.714	10.729							10.985	9.664
L - TOP							1.929	1.916							1.887	2.466
P - BOTTOM							1.874	1.954							1.645	2.453

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01430
S/N 1168-20



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

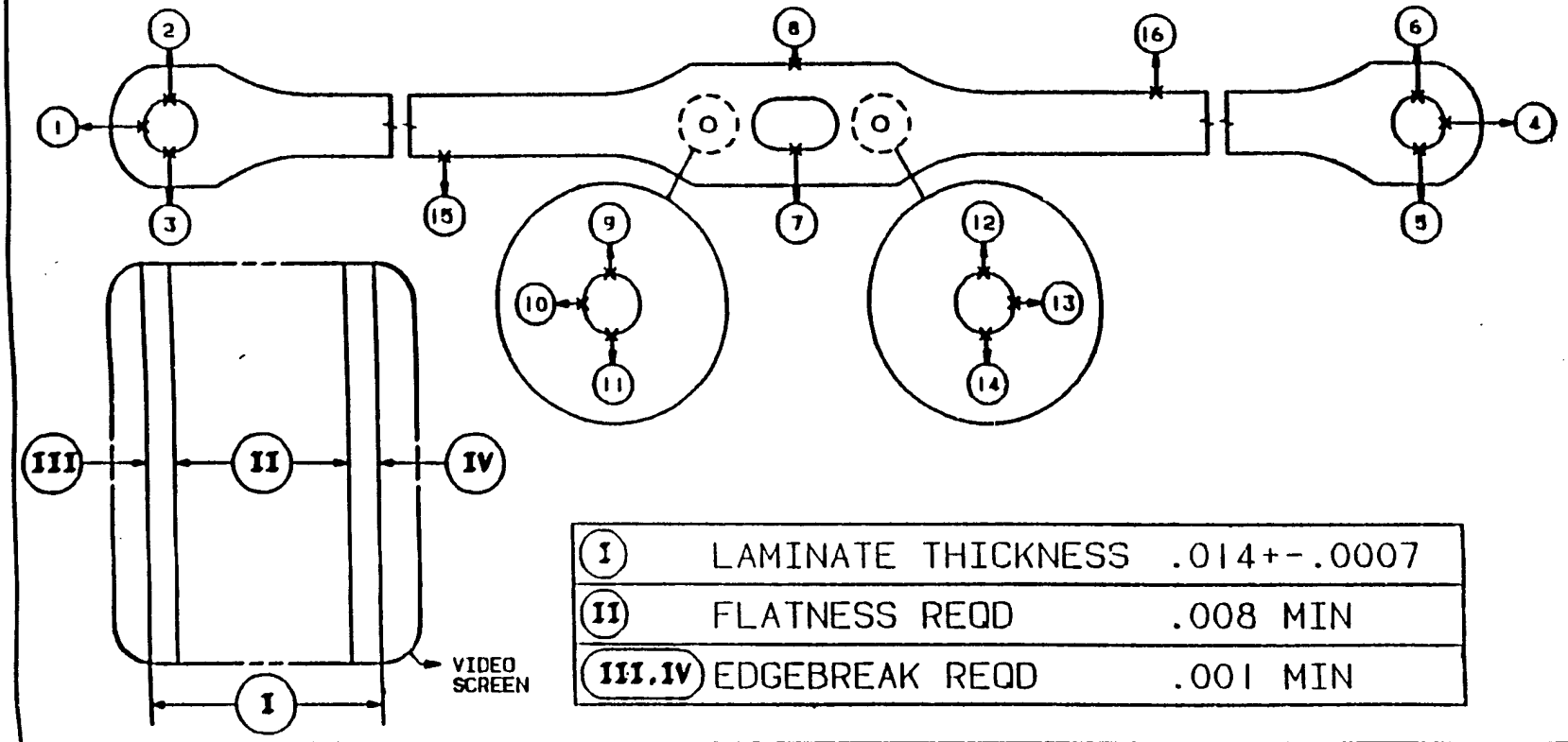
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.630	10.061							9.754	10.073
L - TOP							2.461	2.224							2.550	2.412
P - BOTTOM							2.259	1.983							2.038	2.076

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01440
S/N 1169-2 -- _____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

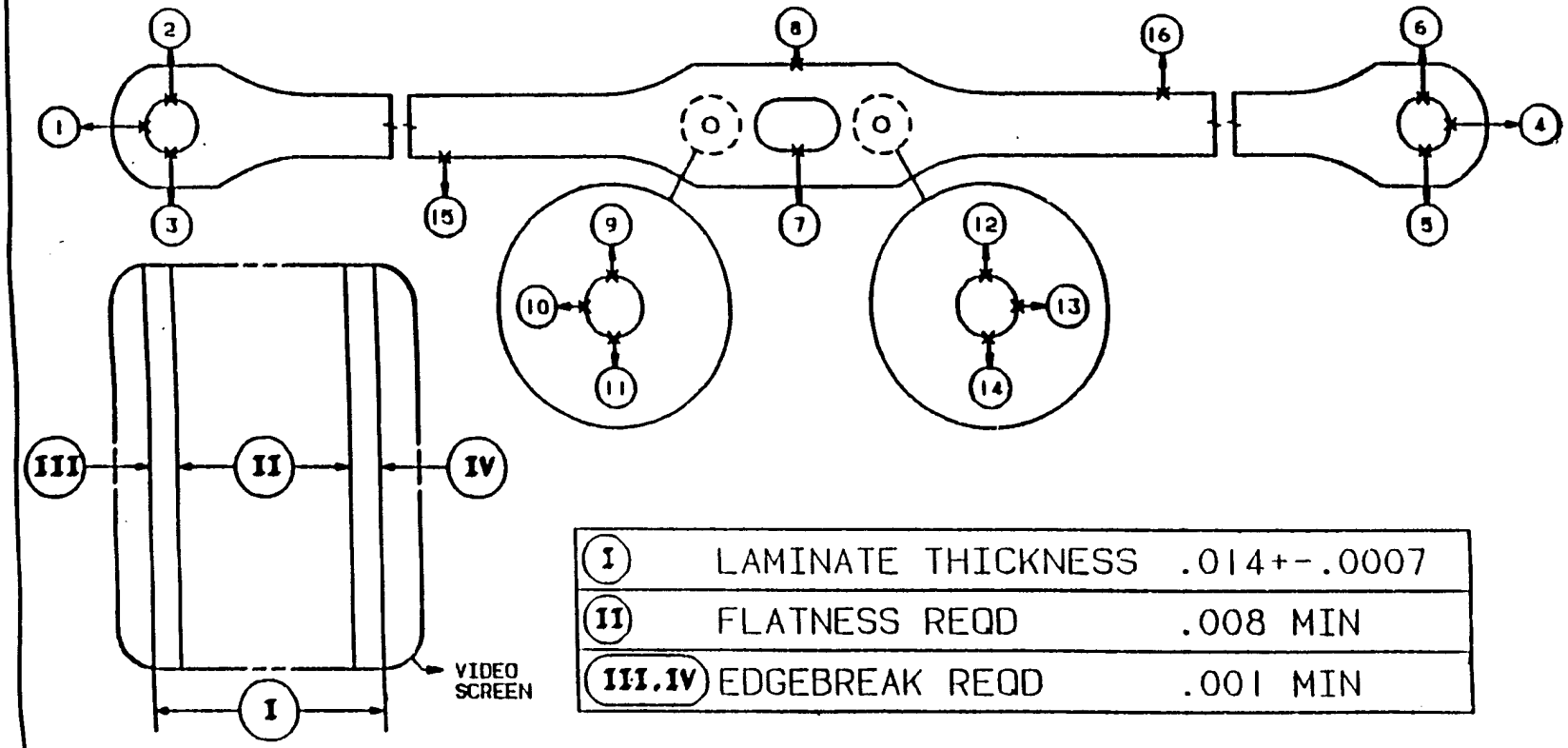
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.034	11.331							10.981	11.020
L - TOP							2.234	1.565							1.626	1.874
P - BOTTOM							2.284	1.635							1.964	1.754

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01440
S/N 1169-13



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

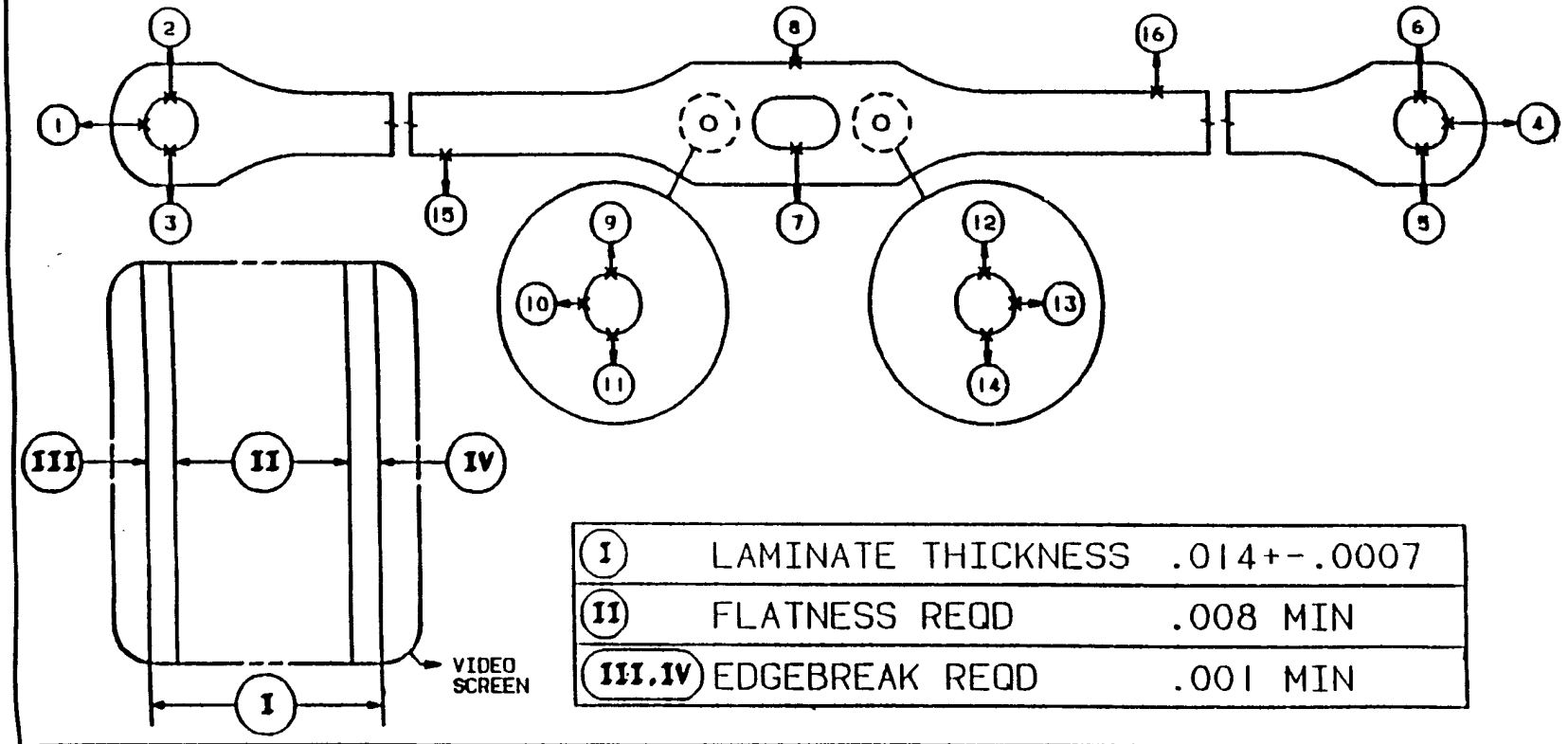
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.238	10.426							10.096	10.882
L - TOP							2.336	1.675							2.376	1.635
P - BOTTOM							2.059	2.510							2.038	2.028

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01435
S/N 1169-22



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

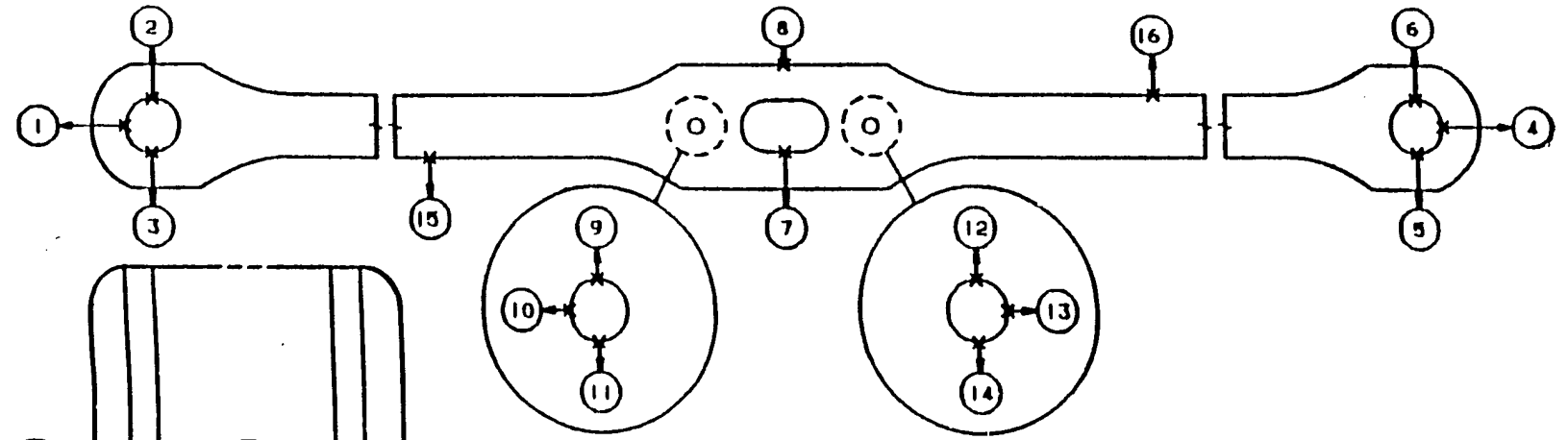
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.257	10.902							9.824	10.270
L - TOP							2.350	1.945							2.412	2.212
P - BOTTOM							1.957	1.786							2.138	1.983

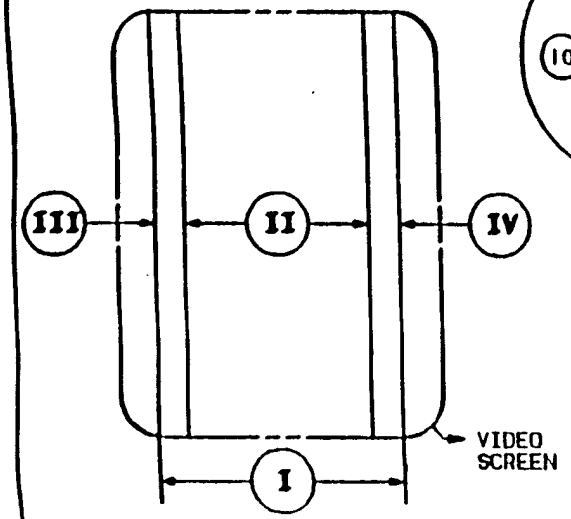
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01435
S/N 1172-7 -- ____





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

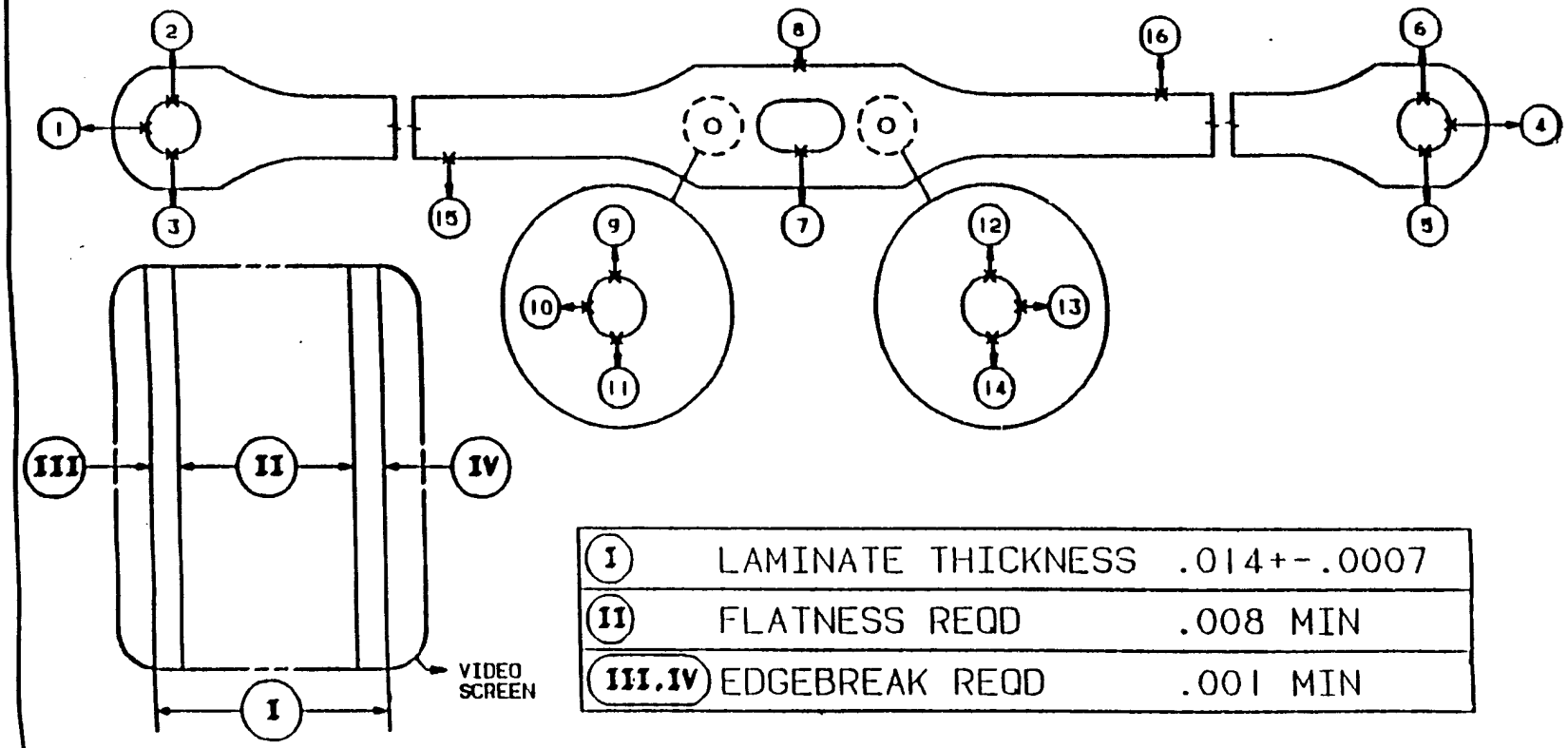
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							9.948	10.338							10.528	11.522
L - TOP							2.223	2.168							2.183	1.580
P - BOTTOM							2.233	2.001							1.941	1.470

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01440**
S/N **1172-16**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

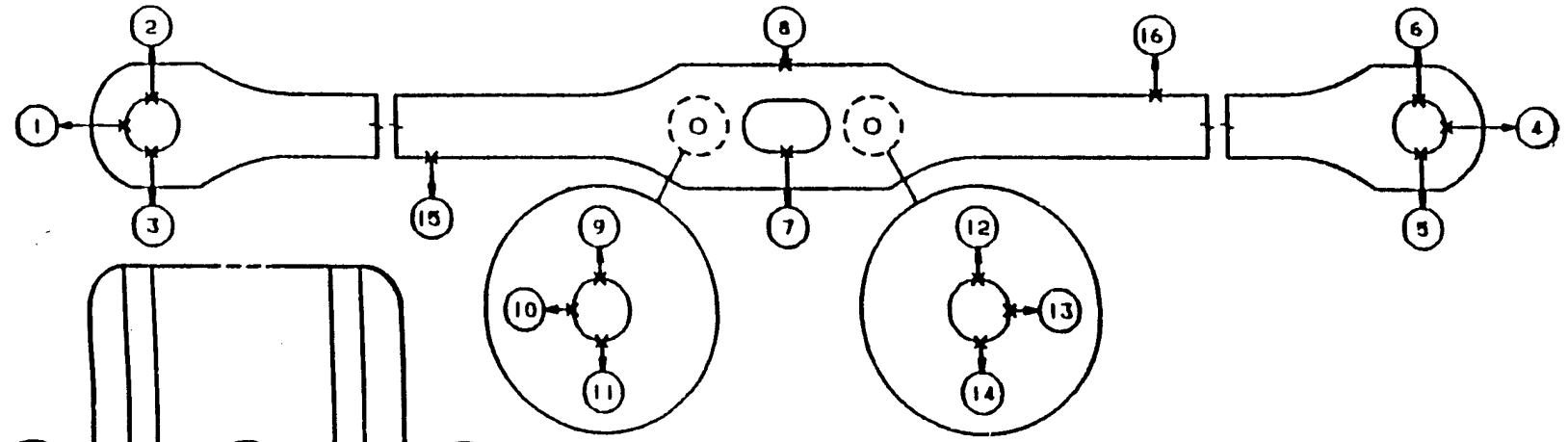
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.426	10.972							10.495	11.308
L - TOP							1.967	1.841							2.185	1.626
P - BOTTOM							2.295	1.730							1.407	1.690

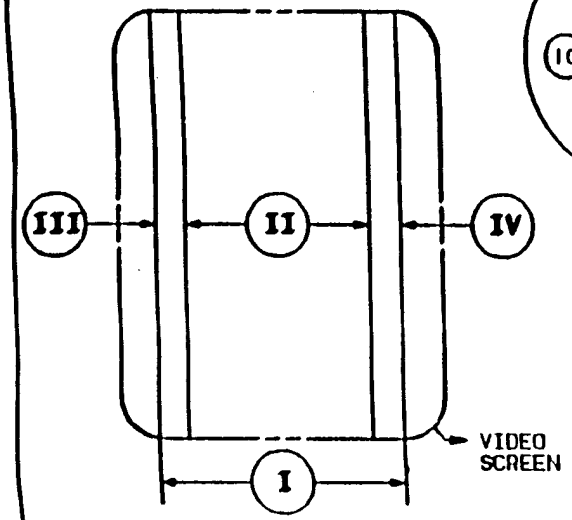
NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1172-21**





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

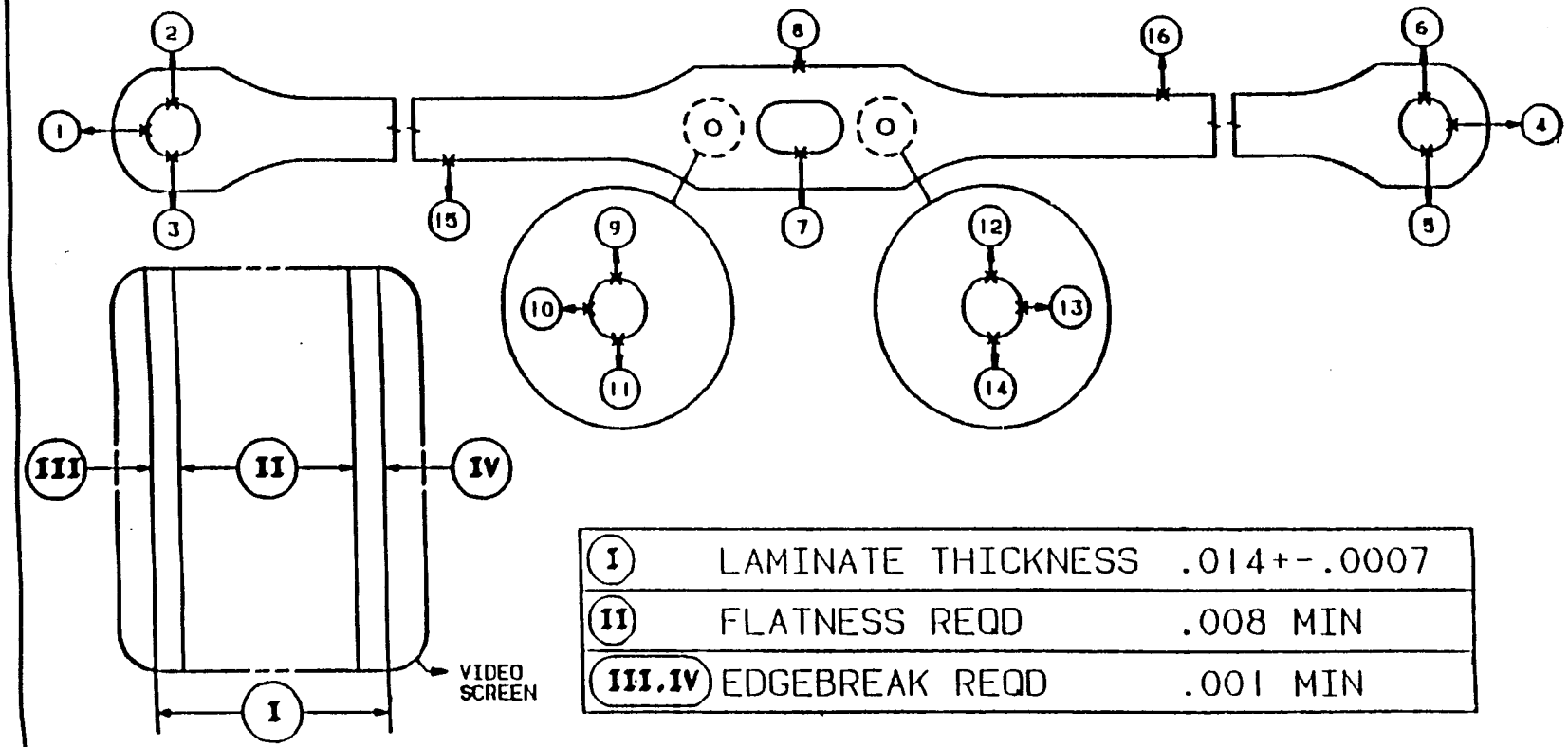
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.223	10.396							10.873	11.037
L - TOP							2.223	1.737							1.786	1.700
P - BOTTOM							2.003	2.185							1.730	1.754

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

DUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1173-2**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

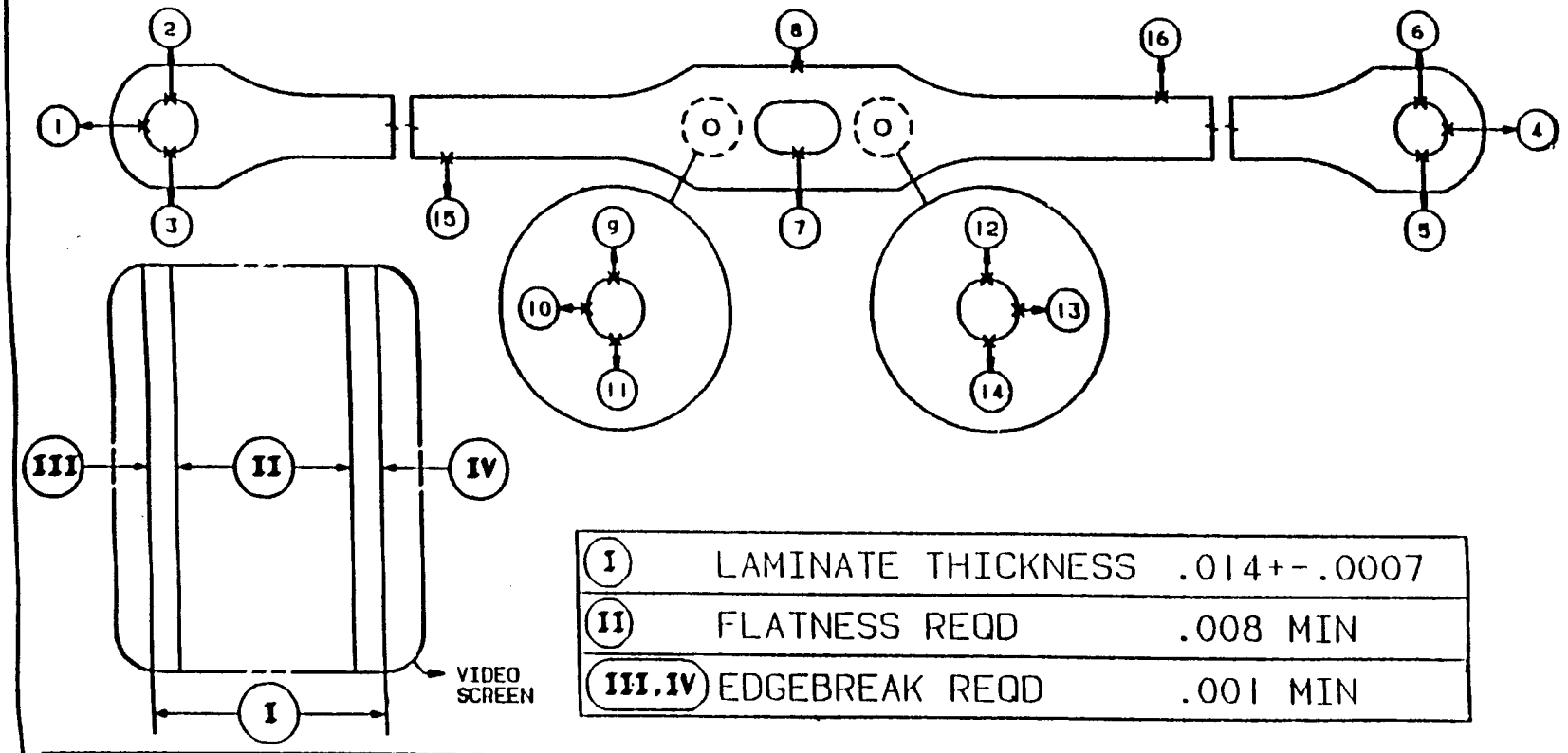
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.159	9.766							10.747	11.174
L - TOP							2.118	2.344							1.792	1.635
P - BOTTOM							2.178	2.302							1.847	1.580

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01430
S/N 1173-9 -- ____



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

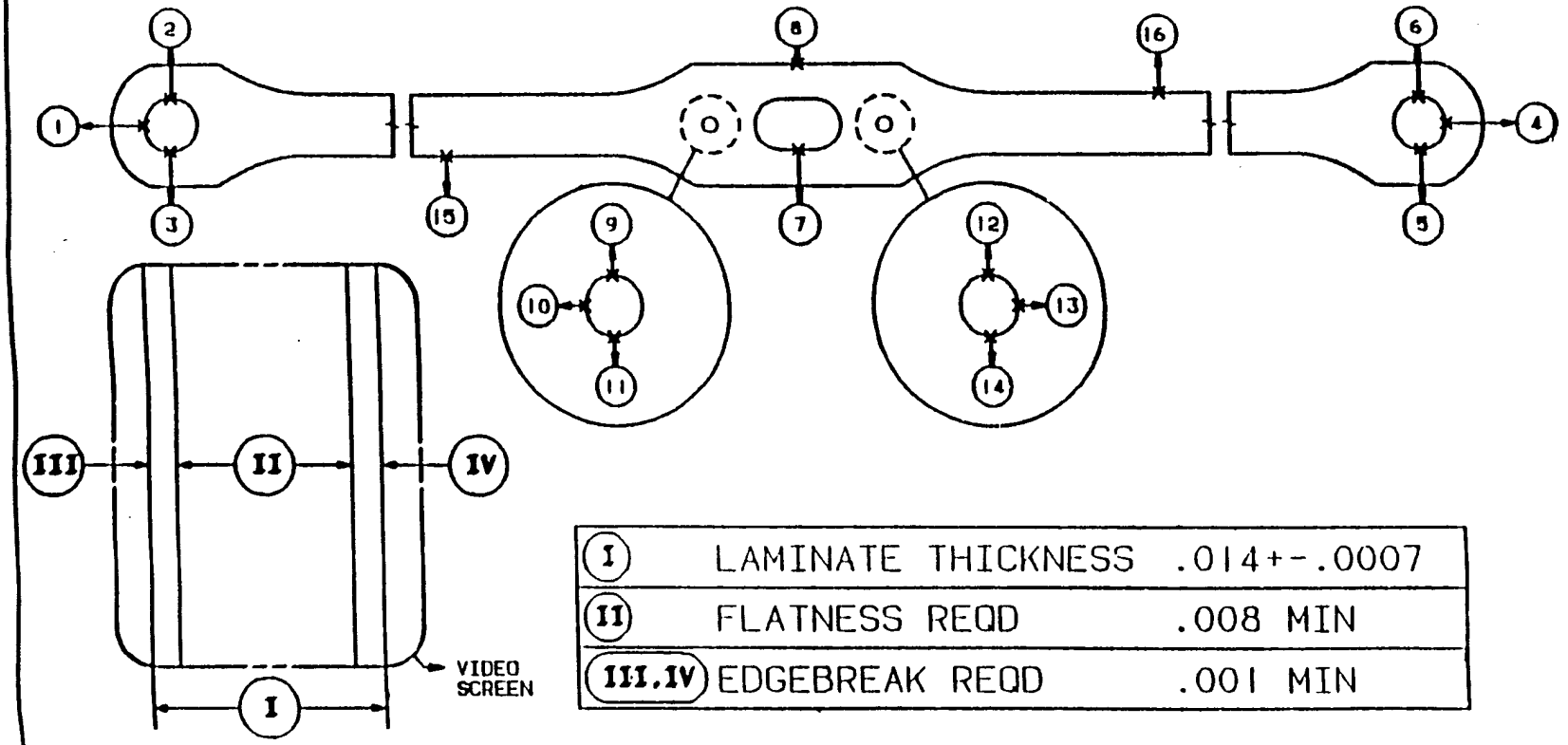
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.147	10.662							10.298	10.257
L - TOP							1.995	2.130							1.964	2.138
P - BOTTOM							2.224	1.682							2.083	2.130

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01425
S/N 1173-19



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

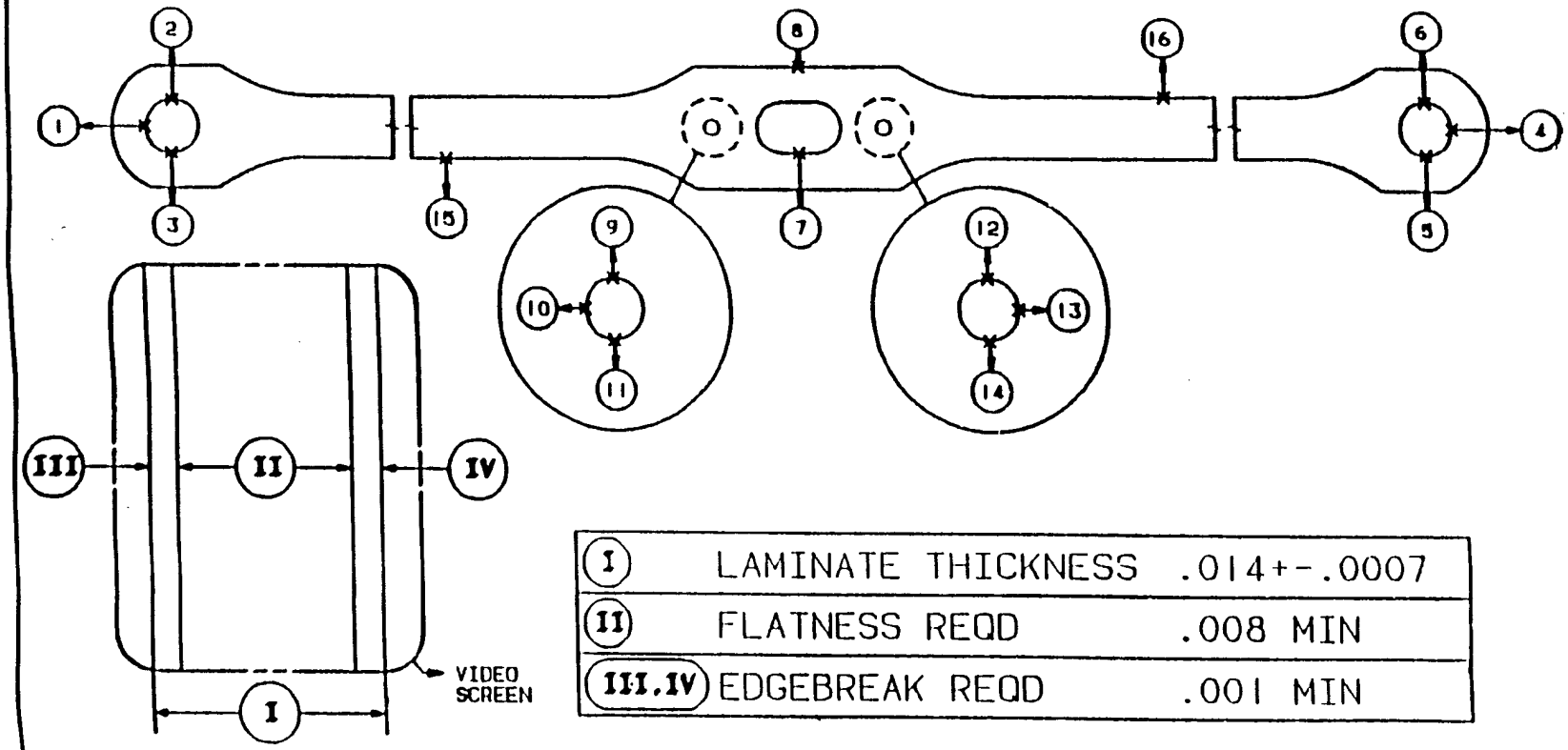
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.459	10.546							10.572	10.573
L - TOP							1.730	1.896							2.240	2.147
P - BOTTOM							2.130	2.130							1.682	1.754

NOTE: NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01445**
S/N **1175-1**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

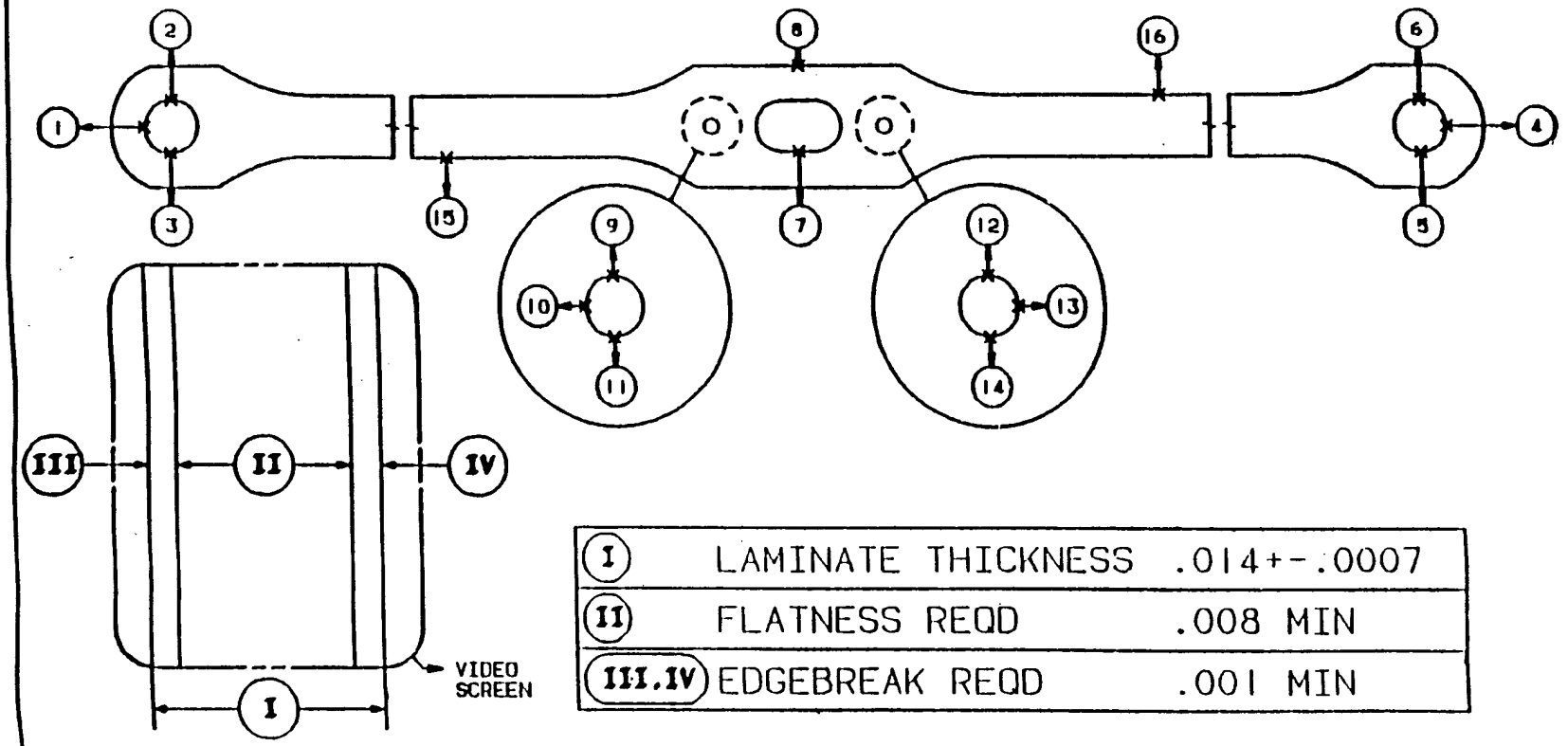
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.155	8.559							10.354	9.622
L - TOP							2.168	2.890							2.013	2.728
P - BOTTOM							2.223	3.057							2.165	2.223

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01425**
S/N **1175-12**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

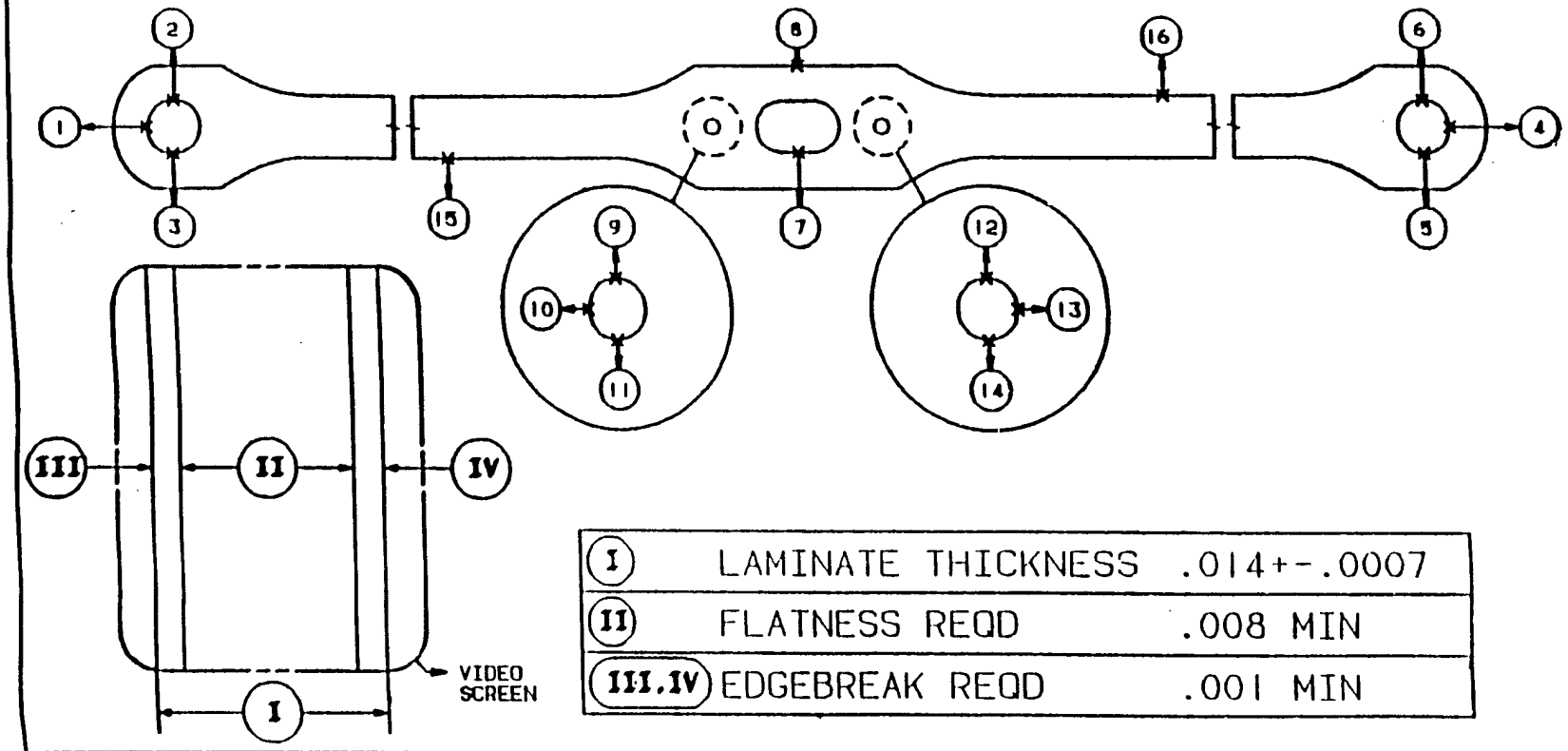
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.307	10.458							10.754	9.540
L - TOP							2.178	1.957							1.952	2.289
P - BOTTOM							2.063	1.957							1.602	2.561

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1175-19**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

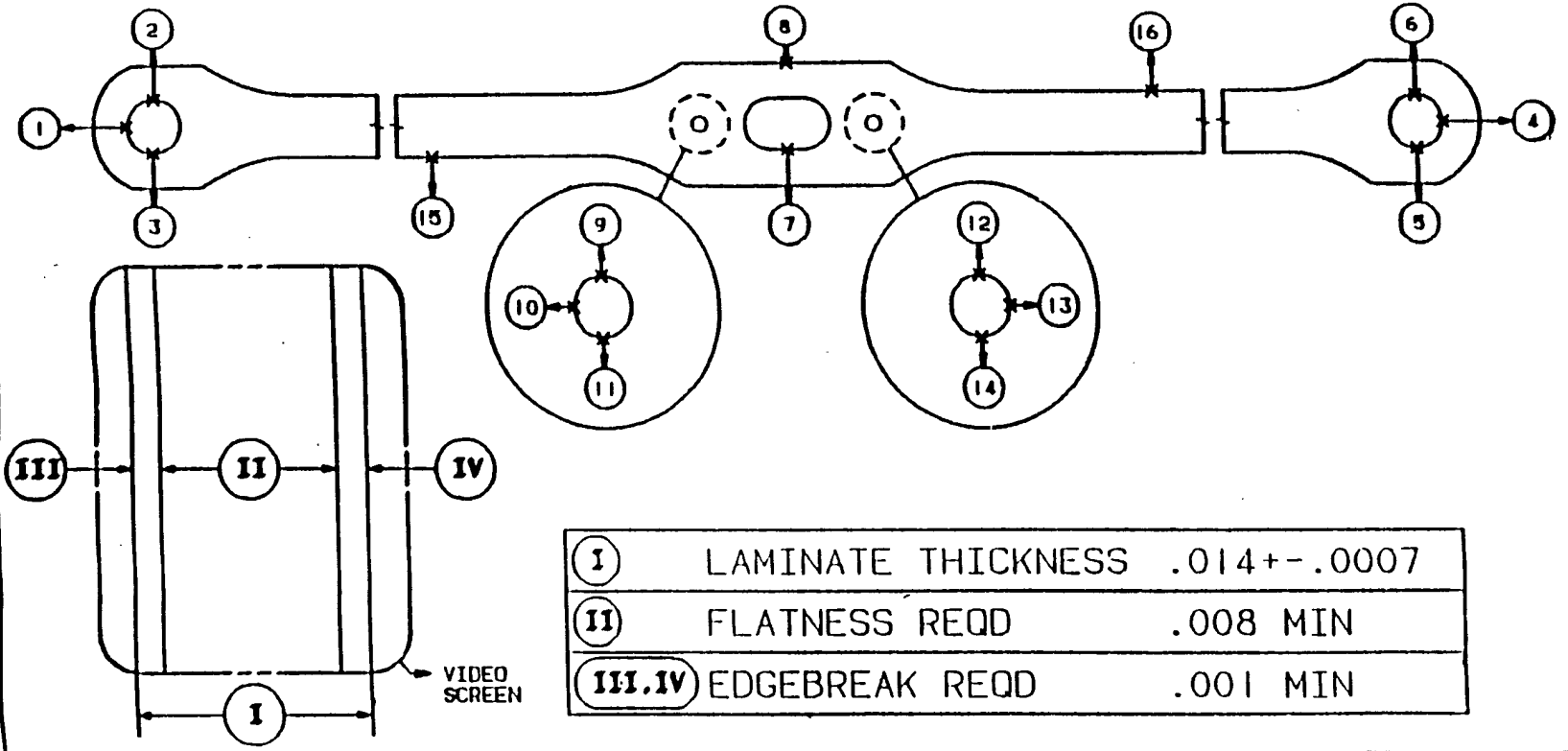
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.115	10.337							10.144	10.380
L - TOP							1.864	2.057							2.244	2.409
P - BOTTOM							2.441	1.945							2.178	1.675

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS 0.01435
S/N 1176-3



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

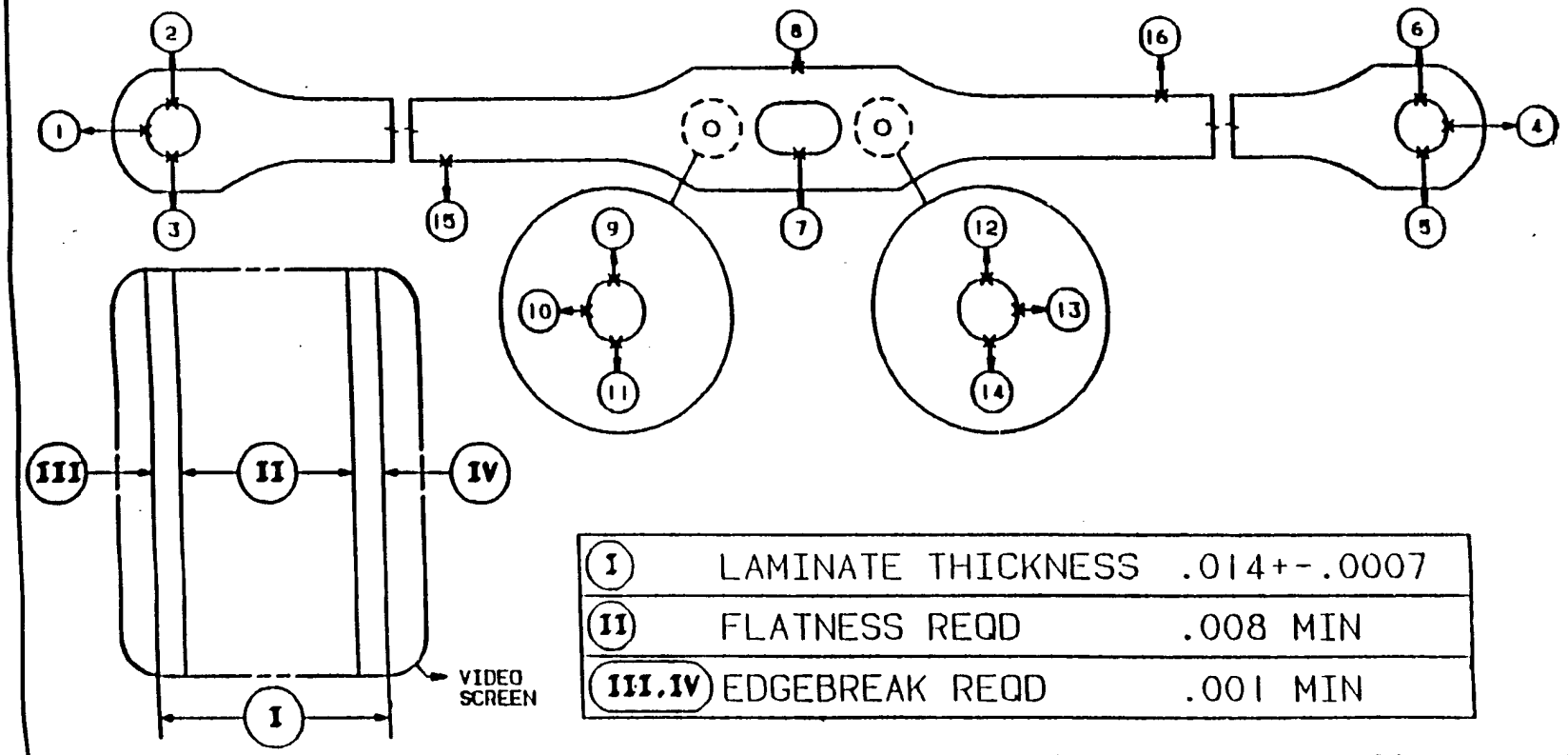
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.306	10.469							11.532	10.370
L - TOP							1.973	2.284							1.654	2.496
P - BOTTOM							2.267	1.730							1.620	1.690

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1176-10**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

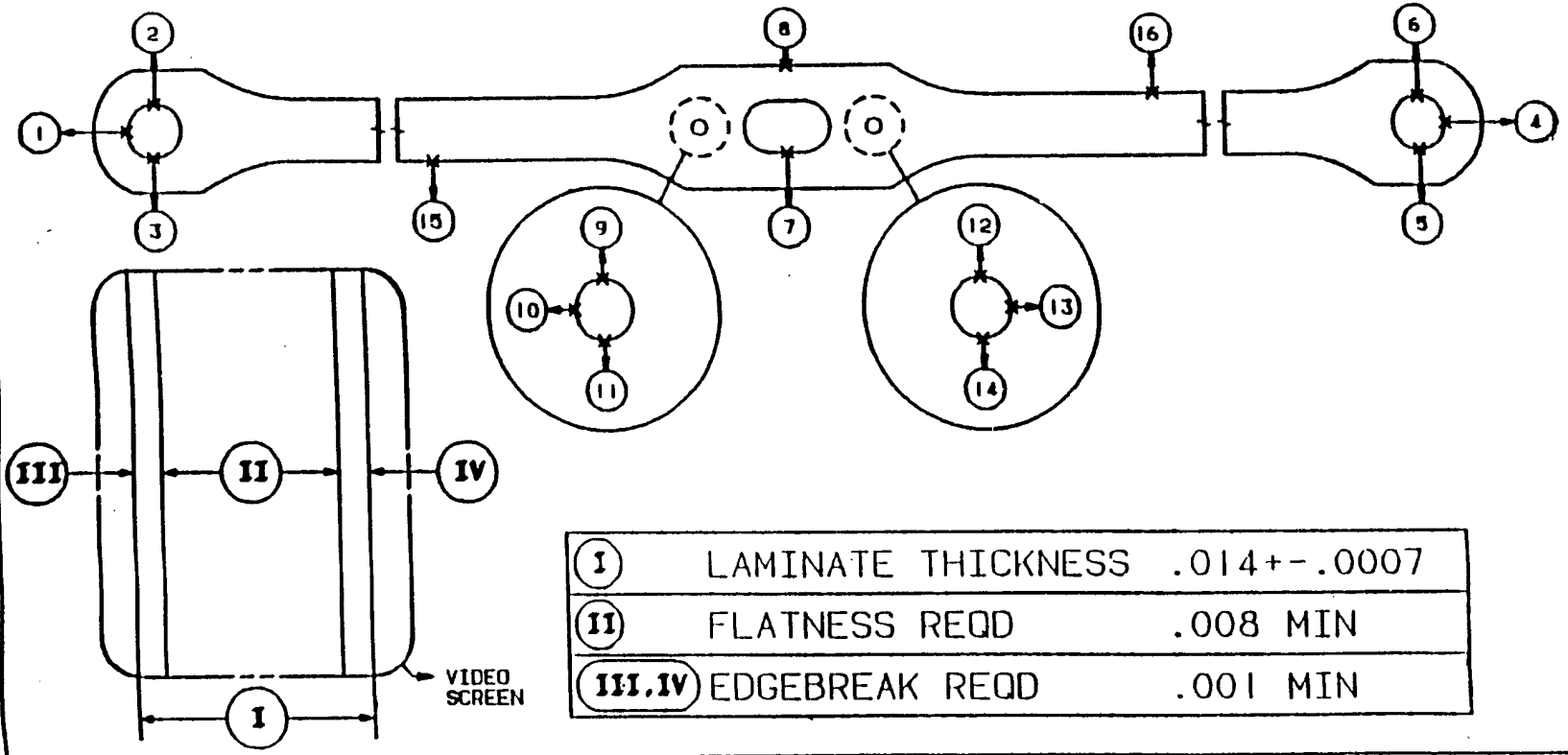
POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.430	10.833							11.071	10.550
L - TOP							2.075	1.847							1.737	1.874
P - BOTTOM							2.092	1.896							1.841	2.103

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
REVISED BY	J REDMAN	09/05/95

THICKNESS **0.01435**
S/N **1176-21**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.681	11.552							10.005	11.705
L - TOP							1.745	1.607							2.523	1.830
P - BOTTOM							2.092	1.515							2.038	1.526

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

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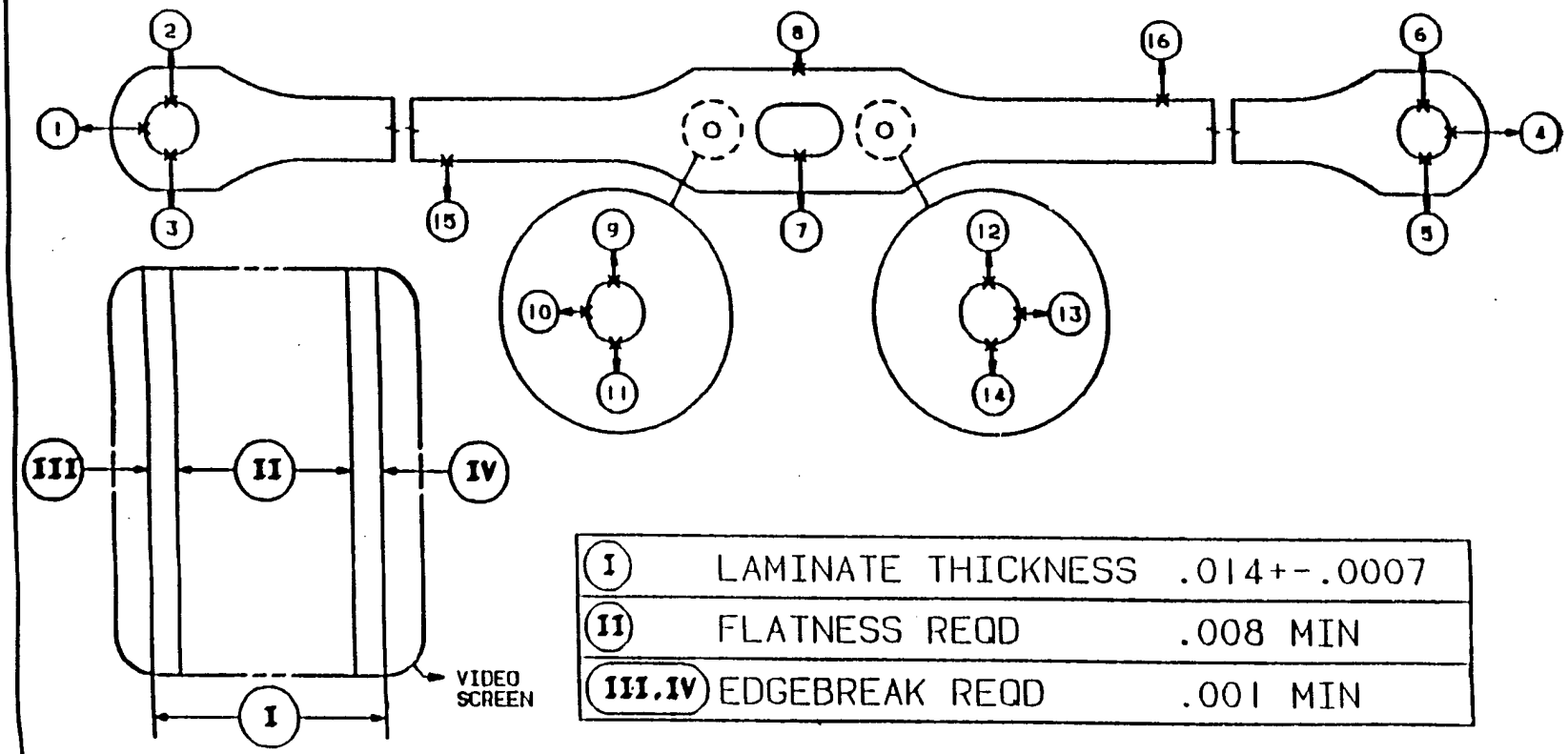
THICKNESS **0.01435**
S/N **1177-5**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III,IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.170	10.016							10.470	10.997
L - TOP							2.147	2.376							2.247	1.712
P - BOTTOM							2.092	2.321							1.655	1.833

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
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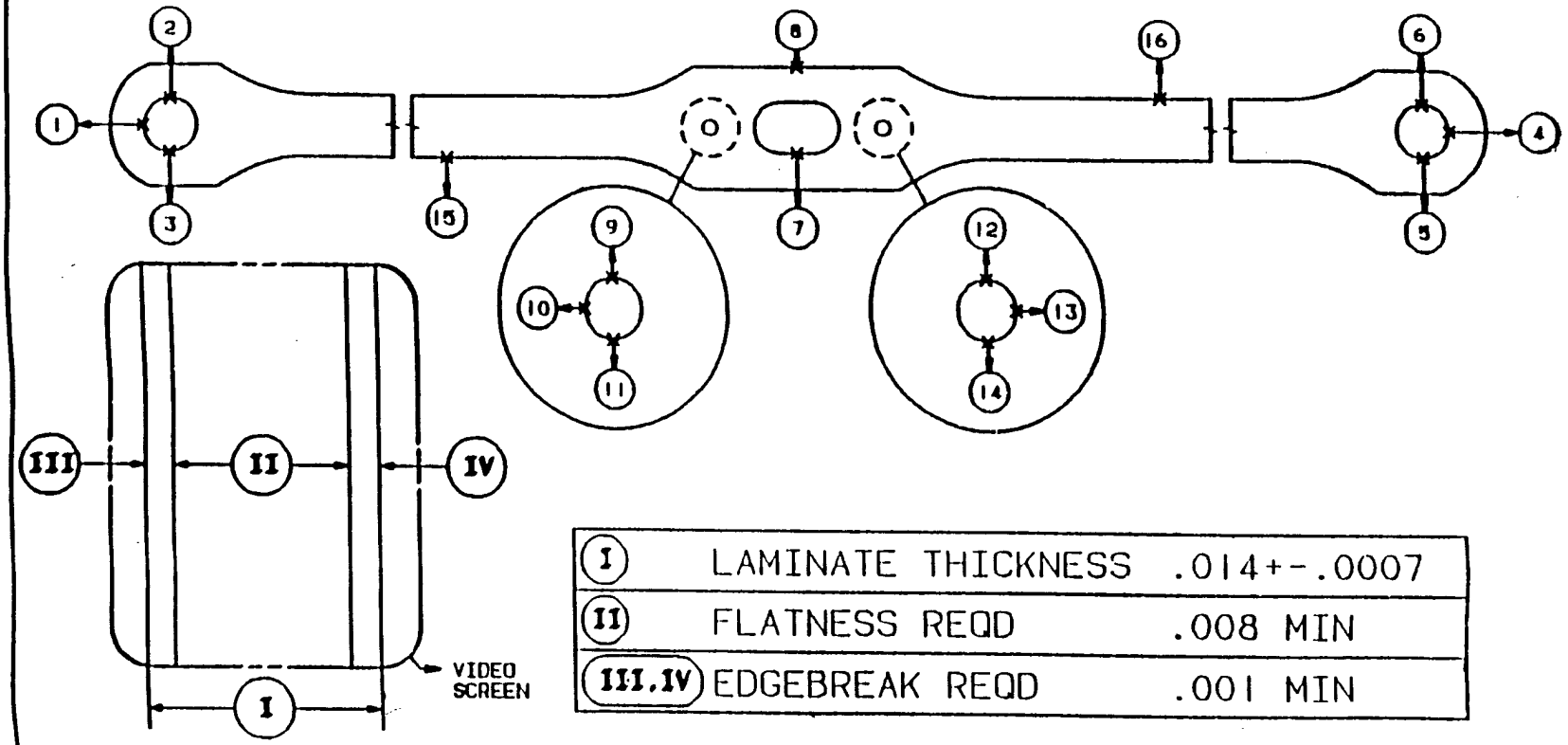
THICKNESS **0.01435**
S/N **1177-11**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.010	10.720							11.164	10.563
L - TOP							2.295	2.138							1.902	2.028
P - BOTTOM							2.130	1.690							1.339	1.864

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
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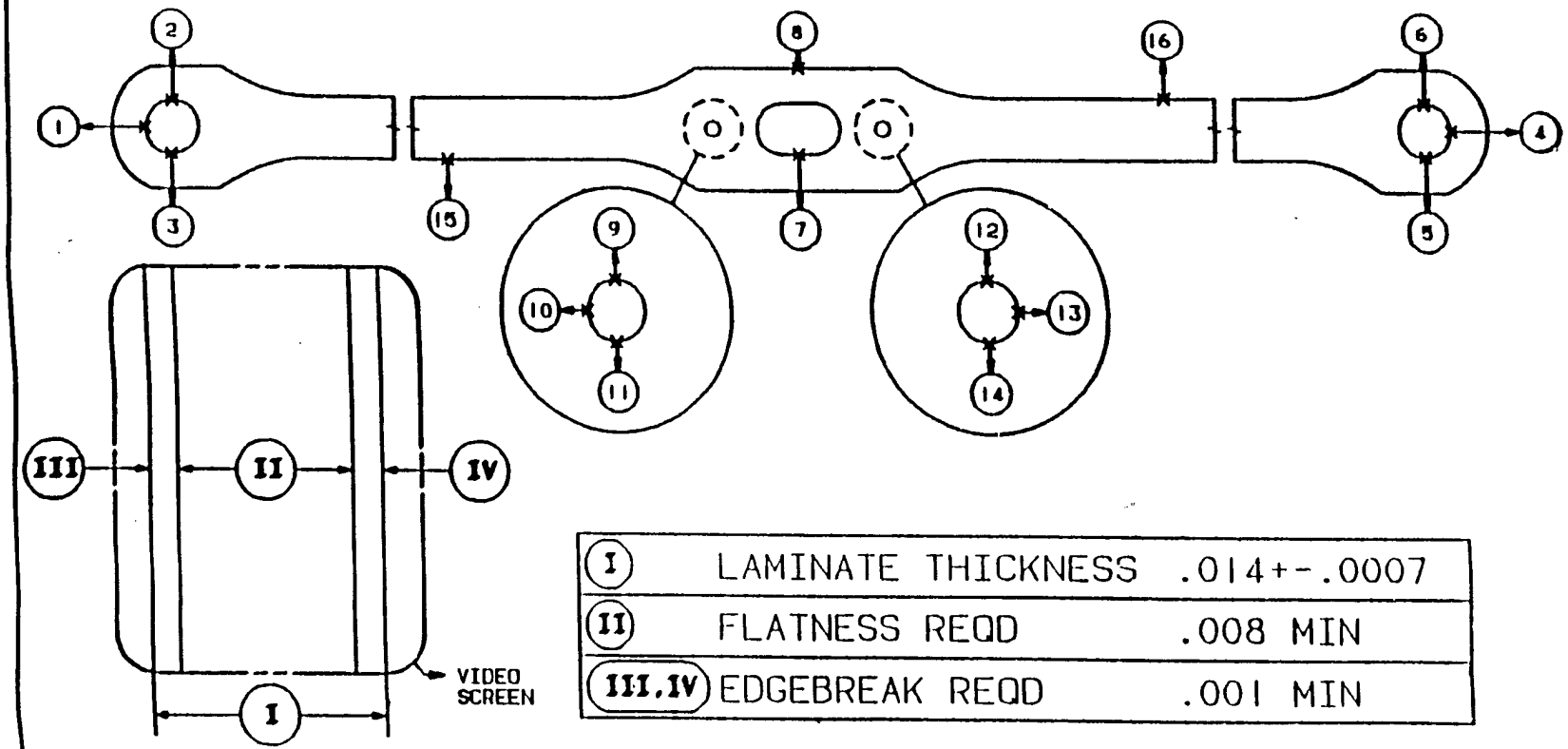
THICKNESS **0.01445**
S/N **1177-17**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							10.596	10.838							11.349	10.132
L - TOP							1.896	2.240							1.580	2.531
P - BOTTOM							2.068	1.454							1.571	1.864

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV.NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL.ENG.	N. PANDA	09/06/86
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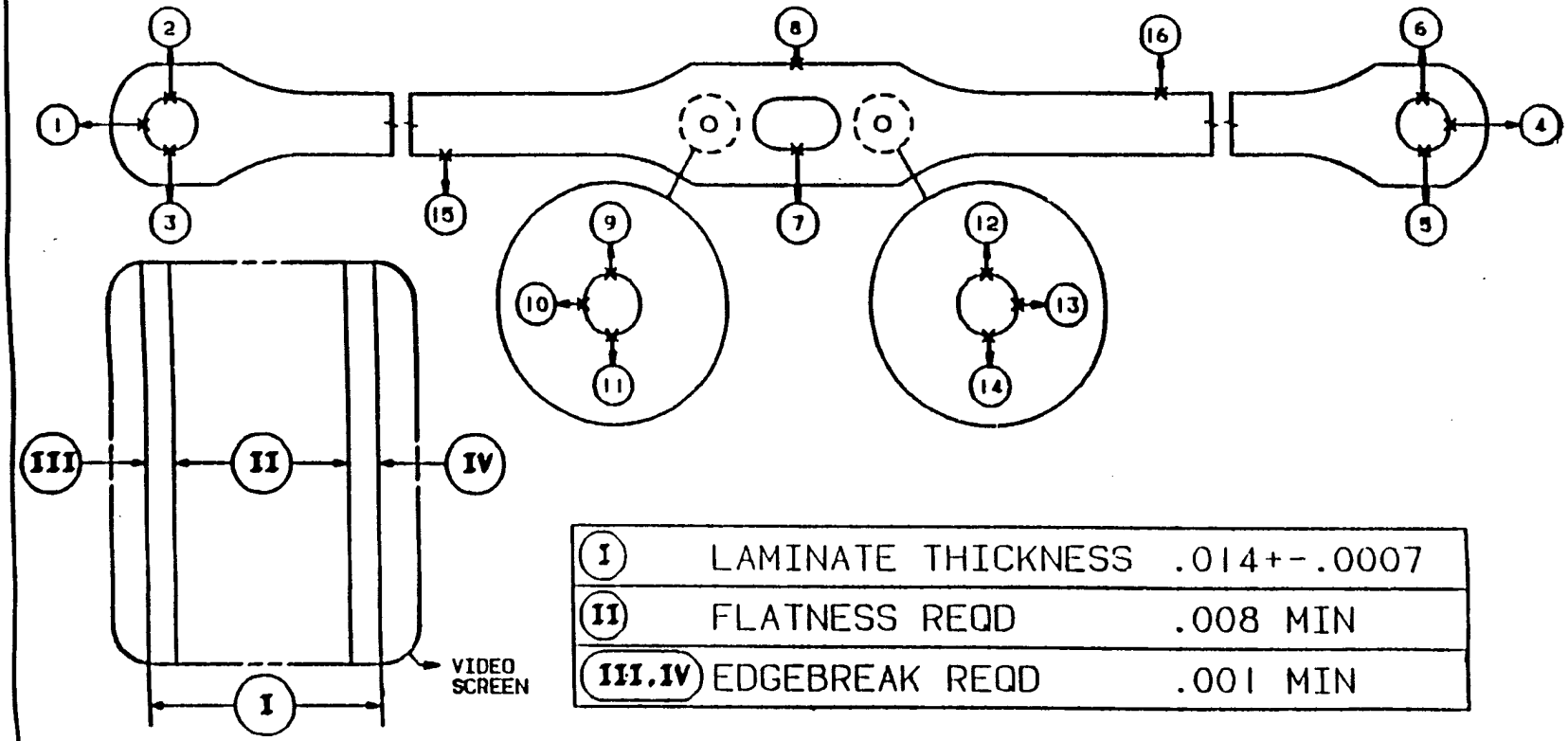
THICKNESS **0.01450**
S/N **EXTRA-1**



I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III.IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							13.983	13.987							13.884	13.902
L - TOP							0.218	0.276							0.279	0.226
P - BOTTOM							0.137	0.234							0.163	0.158

NOTE NOT TO SCALE

SUPP NO.	PART NAME	PART NO.	OPERATION	REV. NO.
Q02	LAMINATE SET-TAIL ROTOR	7-211421023-9	#20 of page 6	E

QUAL. ENG.	N. PANDA	09/06/86
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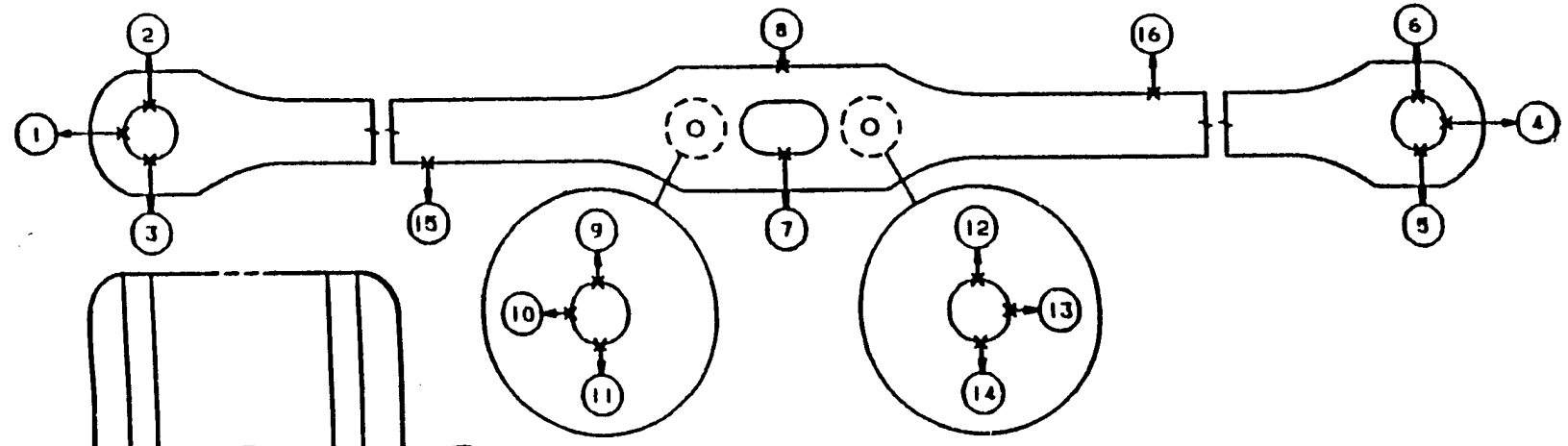
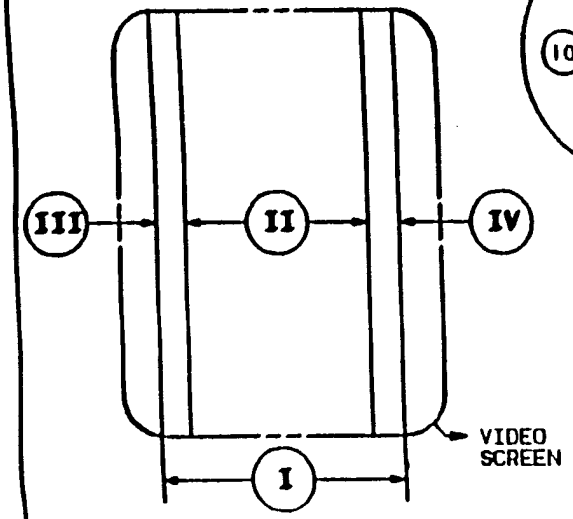
THICKNESS **0.01430**
S/N **EXTRA-2**





I	LAMINATE THICKNESS	.014+-.0007
II	FLATNESS REQD	.008 MIN
III, IV	EDGEBREAK REQD	.001 MIN

POSITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FLATNESS							13.402	13.874							13.687	13.874
L - TOP							0.352	0.310							0.176	0.219
P - BOTTOM							0.287	0.295							0.381	0.237

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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The U.S. Army Research Laboratory-Weapons and Materials Research Directorate (ARL-WMRD) performed a dimensional inspection and metallurgical investigation of AH-64 Apache tail rotor strap pack assemblies and individual laminate sets. All of the dimensional critical characteristics were examined in an attempt to determine the cause of a buckling phenomenon within the strap pack assemblies. Conformance to the manufacturer's governing specifications with respect to the material, heat treatment, and marking requirements was also investigated. The cause of the buckling was attributed to a combination of factors. Dimensional nonconformances were identified. Most of the hole diameters were found to be well below the specified range, causing the assemblies to be forced together. Transposition of the laminates during manufacture was also highly likely to have occurred, adding to the misalignment of the assembly. All other characteristics of the laminates and assemblies were found to conform to the governing part drawings and specifications.

14. SUBJECT TERMS	15. NUMBER OF PAGES
AM-355, dimensional inspection, strap pack, metallurgy	124
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
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_____
City, State, Zip Code

7. If indicating a Change of Address or Address Correction, please provide the Current or Correct address above and the Old or Incorrect address below.

OLD ADDRESS

_____
Organization

_____
Name

_____
Street or P.O. Box No.

_____
City, State, Zip Code

(Remove this sheet, fold as indicated, tape closed, and mail.)

(DO NOT STAPLE)